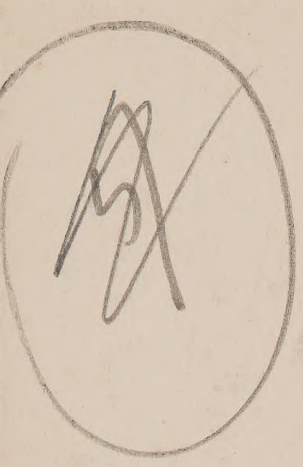

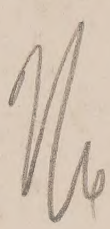

VETERINARY MEDICINE SERIES
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WOUND TREATMENT

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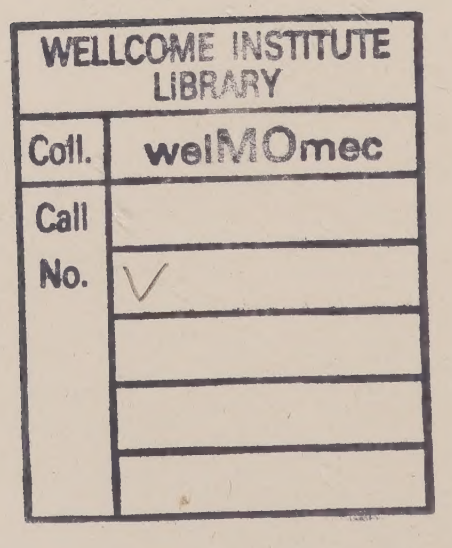

PREFACE

The treatment of wounds in the hands of the average veterinarian has not improved as much in the last decade as have other branches of purely operative surgery. A score of years ago, few veterinarians expected that wounds made in the course of their operations could be healed without infection. Now, the more successful practitioners reproach themselves if a wound of their own making develops sepsis. The treatment of accidental wounds, on the other hand, is much the same now in the practice of most veterinarians as it was a double decade ago—that is, they are treated by washes, ointments, or dusting powders, as the inclination of the practitioner may direct, and seldom is a real conscious effort made to render them germ-free, suture them up, and procure healing by first intention without the development of sepsis.

This average of conditions is not true of the work of all, and it is for the purpose of placing the methods used by a number of the most successful practitioners in the hands of the whole profession that this little volume has been issued. It comprises the better articles on the use of antiseptics, suturing and treatment of wounds in general, that have appeared in the AMERICAN JOURNAL OF VETERINARY MEDICINE during the past four or five years. The editor is convinced that the treatments herein given are practical for the average practitioner, and their careful study will prove of much value to him.

D. M. C.

Evanston, Illinois,
September, 1915.

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DISINFECTANTS AND THEIR STANDARDIZATION

By WATSON LEWIS, D.V.M., Saint Paul, Minnesota

An antiseptic prevents the growth of germs, while a disinfectant kills them. It is hard to say just where antiseptic action leaves off and disinfectant begins, for they are so closely allied that the terms are commonly used synonymously. It is a well known fact that a substance may cause a marked inhibition of bacterial growth and still be of little value as a germ destroyer. For instance, turpentine will retard the growth of spores in solutions of 1 to 75,000, while carbolic acid only retards in a solution stronger than 1 to 1,250. This powerful antiseptic action explains the high efficiency of turpentine in flatulent conditions both in human and in veterinary medicine.

Nothing is used more frequently in veterinary surgery than antiseptics and disinfectants, many of which are standardized. However, such is not the case with coal tar and allied disinfectants, for here no standard has been adopted to protect the consumer against fraud.

These preparations are now offered on the market at prices varying from fifty cents to five dollars a gallon. The five-dollar preparation may be actually cheaper than the fifty-cent preparation, because of its germicidal value. Accurate test shows that there are preparations fifteen to seventeen times more efficient than carbolic acid, but they do not sell for fifty cents a gallon.

The question now arises, "How are we to know the real value of a germicide?" In the last few years, both in this country and in Europe, there have been rapid advancements made in the accurate standardization of disinfectants. It is time that the old statements in textbooks that bichlorid of mercury kills anthrax in so many hours, and Streptococcus pyogenes in so many minutes, should be discarded. The results depend entirely on the strains of the organisms tested and the method used.

One strain of Streptococcus pyogenes may be killed in five minutes while another, by the same method, will require twice the time.

Carbolic acid and the salts of the heavy metals, such as silver, copper, and mercury, have been mostly used as disinfectants. There is now a tendency to discard these for the more easily applied preparations, as their general fault lies in their lack of efficiency in the presence of organic matter—that is, blood and pus.

Another group of disinfectants not used to any appreciable extent but possessing high efficiency, is the essential oils. They owe their germicidal value to their phenol content, which, in some instances, is very high. Thymol, for example, which is a phenol obtained from the oil of thyme, is twenty-five times more powerful than carbolic acid. It is unfortunate that the expense of these oils and the inconvenience of applying them have limited their use, for they are only slightly toxic, do not coagulate organic matter to any appreciable extent, and are only slightly irritating.

The germicidal value of most of the commercial coal-tar disinfectants is due to the cresols—paracresol, metacresol, and orthocresol—which are variable in their germicidal efficiency.

Paracresol and metacresol have much more germicidal power than orthocresol, and the amount of each present in the coal-tar disinfectants may vary markedly in different lots. Therefore it is necessary to determine the percentage of each, in each lot, by fractional distillation.

Several methods have been advanced for the testing of the germicidal value of disinfectants, and lately much work has been done toward standardizing such methods.

The methods of the Lancet commission and Rideal-Walker, and that of Anderson and McClintic of the United States Public Health Service, have all been employed. The Anderson-McClintic method is a modification of the Rideal-Walker method to eliminate some of the variations which may be obtained in the use of that test.

In all such tests the great difficulty lies in finding a procedure by which the *exact value* of the disinfectants may be determined, and a proper relative standard secured in the laboratory.

It must be borne in mind that such a test, no matter how painstakingly and elaborately worked out, is at the best but a laboratory test, and is only an indication of the relative possibilities of the disinfectants under the varying conditions met with in practice.

However, it may be said safely that the Anderson-McClintic method gives a basis for successful testing of disinfectants and at the least will enable us to standardize their action toward the typhoid organism, relative to the action of phenol under the same conditions.

In using the Anderson-McClintic method it is most essential that the exact recommendations of the authors be carried out to the minutest detail. Lack of attention to the different factors concerned in the examination

of disinfectants is responsible for most of the discrepancies in results obtained by different workers with the same disinfectant. Close attention to the details of the method used is the only way in which uniform results can be secured.

The factors which bring about the greatest variance in results obtained, and which must be considered of the most importance in the conduct of the test, are (1) the organism used, (2) temperature of the experiment, (3) amount of culture, (4) amount of disinfectant, and (5) the media used in subculture, (6) standardized solution of phenol.

The coefficient obtained by different species, and by different strains of same species, may vary greatly, so it is essential that one species be adopted and the cultivation of the strain employed be as nearly standardized as possible. For this reason the Hopkins strain of B. typhosus is best employed. It is cultivated on standard extract broth made from Liebig's extract of beef in accordance with the methods adopted by the American Public Health Association for water analysis. It is important that the reaction of the medium be just 11.5. One loopful of 4-millimeter platinum loop of the culture is carried over every twenty-four hours on three successive days. Before being added to the disinfectant the culture is filtered through sterile filter paper and brought to a temperature of 20 degrees Centigrade in a water bath.

One tenth of a cubic centimeter of the culture is used, added to 5 cubic centimeters of the disinfectant dilution at a temperature of 20 degrees Centigrade. Measure the amount of culture with a pipette graduated to 1-10 cubic centimeter.

When the proper dilutions of the disinfectant to be tested and the phenol controls have been made and

placed in their respective test tubes, all is placed in a water bath so that the solutions may be brought to a temperature of 20 degrees Centigrade. A standard solution of pure phenol is made and standardized by the United States Pharmacopeia method to contain a five per-cent solution by weight. Dilutions are made fresh from this each day. When everything is ready, 1-10 cubic centimeter of the culture is added by the pipette to each of the dilutions in the seed tubes.

The solutions are planted from the seed tubes into the culture tubes every two and one-half minutes up to fifteen minutes, and for this a 4-millimeter platinum loop, United States standard, 23-gauge wire is used.

In adding the culture to the dilution the best method is to tip the test tube at an angle of forty-five degrees, lightly touch the pipette against the side of the tube below the surface line, and then shake gently. The broth tubes are placed in the incubator at 37 degrees Centigrade for forty-eight hours.

The mean between the strength and time coefficients is used for determining the coefficient. To determine the coefficient, the figure representing the degree of dilution of the weakest strength of the disinfectant that kills within two and one-half minutes is divided by the figure representing the degree of dilution of the weakest strength of the phenol control that kills within the same time. The same is done for the weakest strength that kills in fifteen minutes. The mean of the two is the coefficient.

As has been stated before, the coefficient simply represents the germicidal power of the disinfectant tested, relative to the power of phenol on the same organisms under the same conditions, and should be accepted only as such.

However, it is the best we have at present, and great thanks are due to Rideal-Walker and to Anderson-McClintic for carrying us this far in obtaining a procedure by which we may begin to standardize disinfectants.

BACTERICIDAL PROPERTIES OF COMMON ANTISEPTICS AND DISINFECTANTS

By H. LOTHE, D.V.M., and B. A. BEACH, D.V.M.,
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A new era in surgery began with the work of Lister, who in 1867 studied the effect of disinfection upon wound healing and introduced carbolic acid as a disinfectant. As the science of bacteriology developed, our knowledge of disinfectants and disinfection increased and will continue to increase and may change as new bacteriological data are collected that change the science of bacteriology. It therefore follows that the final word on disinfection has not yet been said, hence a conclusive statement of our knowledge of disinfection cannot be given. Nevertheless, sufficient experimental data have already been collected to determine certain fundamental principles upon which scientific disinfection is based. Judgment as to the value of any disinfecting agent must, therefore, be made largely from a bacteriological point of view.

As we all know, the fundamental principle of disinfection is the destruction of bacteria by means of chemicals or heat (commonly called sterilization). In this article disinfection by means of chemicals only will be considered. Chemicals are used for these purposes: (1) to render innocuous buildings and other inanimate objects that have come in contact with germs of various infectious diseases; and (2) to prevent the entrance of organisms to the animal body and to kill organisms

that have already gained entrance to the animal body. The latter concerns the surgeon, while the former is a matter of primary interest to the sanitarian. A veterinarian must necessarily act in both of these capacities. The fundamental principles of disinfection are the same for both the surgeon and the sanitarian, although each has peculiar problems that do not concern the other. To the surgeon the question of toxicity of the disinfectant to higher animal life becomes an important question, while to the sanitarian this is not so important. The ideal disinfectant is one absolutely non-toxic to the animal body but highly toxic to bacteria. Surgeons are still looking for this ideal disinfectant.

Disinfectant and Antiseptic

For the sanitarian chemicals that kill bacteria are ideal, and are known as *disinfectants.* Such agents are, however, as a rule, too toxic for the surgeon, who uses agents that prevent the growth of bacteria and are known as *antiseptics.* The same chemical agent may be both an antiseptic and a disinfectant, depending upon concentration.

Cauterization

The surgeon occasionally uses agents that are toxic to tissues which are known as *caustics.* These agents kill both tissue and bacteria cells, and conditions obtain at times, such as bites from rabid dogs, when this drastic method is of primary importance.

Factors Affecting the Action of Antiseptics

There are various factors that affect the action of disinfectants and antiseptics, as follows:

1. Type of Organism.—In the early days of antisepsis, disinfectants were tested bacteriologically with the idea of discovering some chemical agent that would destroy all known bacteria when used in a weak solution. No such universal antiseptic has been found. On the contrary, it has been found that different antiseptics have a selective action upon certain types of organisms. For example, bichlorid of mercury is a most powerful disinfectant for anthrax, but has only a weak action on tubercle bacilli and is much less effective than some other drugs (creolin, lysol, alcohol) for superficial disinfection of the skin, while carbolic acid is relatively ineffective against tetanus bacilli, anthrax spores, and tubercle bacilli. It therefore follows that in disinfection the different organisms and bacteria must be considered individually. In general, it can be said that spore-bearing bacteria require stronger disinfectants than non-spore bearers. Here again individual differences in resistance of species of spores and vegetative forms manifest themselves. It is, therefore, difficult to make a comparative table of individual drugs. In general, the strongest disinfectants which also destroy spores are mercuric chlorid, silver nitrate, iodin, creolin, lysol, liquor cresolis compound and other cresol preparations, and formalin. The weaker disinfectants which kill only spore-free organisms are coal tar, carbolic acid, salicylic acid, dyes, boric acid, and calcium lyes (whitewash) and acids.

Individual Resistance of Organisms.—The individual resistance of different organisms varies. Some infectious agents are very readily destroyed while others are very resistant. For practical purposes disease-producing micro-organisms may be divided into two groups on the basis of their power to resist disinfection.

1. REQUIRING STRONG DISINFECTANTS:
   - Anthrax spores
   - Tetanus spores
   - Tubercle bacilli
   - Blackleg spores
   - Rabies virus

2. REQUIRING WEAKER DISINFECTANTS:
   - Glanders bacilli
   - Hemorrhagic septicemia bacilli
   - Abortion bacilli
   - Foot-and-mouth disease virus, and other bacilli

Pus organisms (Staphylococci and Streptococci) occupy an intermediate position. They are more resistant than other vegetative forms but less so than spores. They, however, require strong disinfectants.

2. TEMPERATURE.—The higher the temperature the greater is the disinfectant property of a given chemical. Practical application of this is made by having the solution of disinfectants as warm as possible when in use.

3. CONCENTRATION.—The stronger the concentration the more effective is the germicidal action. Creolin, however, is an exception to this rule that concentrations where emulsification is complete (two to three per cent) are most efficient. Concentrations of ten to twenty per cent are not relatively as efficient because a great percentage of the creolin is not emulsified and hence not entirely effective. Stated in other words, up to concentrations where emulsification is complete, the disinfection coefficient varies directly as concentration, but in higher concentration the ratio of increase is smaller—that is, a twenty-per-cent solution has not ten times the disinfectant properties of a two-per-cent solution.

4. DURATION OF ACTION.—For action, a certain lapse of time is necessary, which varies with the individual antiseptic on the one hand and the type of organism on the other. With some disinfectants the action on

certain organisms is almost immediate, while with others a greater lapse of time is necessary.

5. Presence of Organic Matter.—Under practical conditions disinfectants are used in the presence of organic matter, and it has been found that considerably higher concentration and greater length of time are necessary for most disinfectants under such conditions. Such organic material as blood, manure, and urine are often present where disinfection and antisepsis are practiced. These contain chemical bodies that unite with the antiseptic used, rendering it inert. It is therefore necessary to use enough disinfectant to combine with the organic matter and enough more to act as an antiseptic and disinfectant. This factor will naturally vary with the kind and amount of organic matter present.

To summarize, then, we find that the disinfectant properties of any given chemical depend upon:

1. Type of organism
2. Temperature at which it acts
3. Concentration
4. Length of time acting
5. Amount and character of organic matter

Earlier in this article mention was made of the fact that scientific disinfection was based entirely upon bacteriological tests. In determining the value of any given disinfectant it therefore becomes necessary to take into consideration each of the five above-mentioned factors so that a comparison of different antiseptics can be made on the same basis. It is necessary that they all act upon the same organism, at the same temperature and concentration, for the same length of time, and in the presence of the same amount and composition of organic matter.

Hygienic Laboratory Phenol Coefficient

A method of standardizing or testing antiseptics has been developed and described by Anderson and McClintic in Bulletin 82 of the Public Health and Marine Hospital Service, Washington, D. C., known as the "Hygienic Laboratory Phenol Coefficient" method, which takes into account all of the above-mentioned factors. It is sufficient for our purpose at this time merely to state how this method meets these requirements without going into the details of laboratory manipulations.

1. Type of organism used is a twenty-four-hour broth culture of B. typhosus (the organism of typhoid fever in a man)
2. Temperature is 20 degrees Centigrade
3. Concentrations of various strength
4. Length of time varies from two and one-half to fifteen minutes for each dilution or concentration
5. Organic matter consisting of two per cent of peptone and one per cent of gelatin is used.

To give more information regarding any given disinfectant, this method prescribes that its germicidal properties be determined upon typhoid both in the absence and in presence of organic matter.

For purposes of comparison the results are expressed in figures known as the "hygienic laboratory phenol coefficient," which simply means the germicidal properties of the disinfectant in question expressed in terms of phenol or carbolic acid, reducing the value of all disinfectants to a common language or medium of exchange, so to speak, just as the value of wheat, beef, and gasoline is expressed in terms of dollars and cents rather than expressing the value of a bushel of wheat in pounds of beef, or pounds of beef in gallons of gasoline. The phenol coefficient, then, gives you the bactericidal property of the disinfectant in question compared to phenol.

The table on this page shows the results obtained by this method with a well-known antiseptic with which many of you are familiar.

Creolin-Pearson—Results of a Test without Organic Matter

(+ means growth; — means no growth)

Sample	Dilution	Time culture exposed to action of disinfectant for minutes: 2½	5	7½	10	12½	15	Phenol coefficient: 200 + 400
Phenol	1:80	—	—	—				——— ———
	1:90	+	—	—	—	—	—	80 + 100
	1:100	+	+	+	+	+	—	——————— =
	1:110	+	+	+	+	+	+	2
Creolin	1:200	—	—	—	—	—	—	2.50 + 4.00
	1:225	+	—	—	—	—	—	——————— =
	1:250	+	—	—	—	—	—	2
	1:300	+	—	—	—	—	—	3.25
	1:350	+	+	+	—	—	—	
	1:400	+	+	+	+	—	—	
	1:450	+	+	+	+	+	+	
	1:500	+	+	+	+	+	+	

Results of a Test with Organic Matter

Sample	Dilution	Time culture exposed to action of disinfectant for minutes: 2½	5	7½	10	12½	15	Phenol coefficient: 160 + 275
Phenol	1:80	—	—	—	—	—	—	——— ———
	1:90	+	+	—	—	—	—	80 + 90
	1:100	+	+	+	+	+	+	——————— =
	1:110	+	+	+	+	+	+	2
Creolin	1:150	—	—	—	—	—	—	2.00 + 3.05
	1:160	—	—	—	—	—	—	——————— =
	1:180	+	—	—	—	—	—	2
	1:200	+	—	—	—	—	—	2.52
	1:225	+	+	—	—	—	—	
	1:250	+	+	—	—	—	—	
	1:275	+	+	+	—	—	—	
	1:300	+	+	+	+	+	+	

This table illustrates very clearly the effect of the various factors that influence the action of a disinfectant. For instance, in the 1 to 80 dilution of phenol

there was no growth in two and one-half minutes; in the 1 to 90, however, there was, showing the effect of concentration. The lower table shows the effect of organic matter. For example, it took the 1 to 90 dilution five minutes to kill against two and one-half minutes without organic matter, or just twice as long. The 1 to 100 dilution failed to kill in two and one-half minutes but was bactericidal in fifteen minutes, showing the effect of exposure.

Now the question arises as to what practical value such tables as these have. There are upon the market innumerable kinds of disinfectants put up by different commercial houses at greatly varying prices, based, not upon their efficiency as germ killers, but upon the percentage of profit the manufacturer thinks he ought to get. For example, mixtures containing varying amounts of creolin are upon the market. All have the property of forming a white emulsion with water and in addition a more or less aromatic odor. The idea seems to have gained precedence that odor and disinfecting properties go hand in hand. The more penetrating the odor and the more milky the solution, the better the antiseptic, seems to be the belief. There are preparations on the market possessing both the latter qualities to a superlative degree but having little action other than imparting a pronounced odor to your medicine case and clothing. The only true criterion of the value of any given preparation as a germ killer is a bacteriological determination. Every practicing veterinarian should insist upon knowing the phenol coefficient of the antiseptic purchased. The time is coming when all commercial concerns will place the coefficient upon their labels, as some houses are already doing.

When the phenol coefficient and price per gallon of a number of disinfectants are known, it is possible to cal-

culate from the price of pure phenol which will be the most economical to buy. It is apparent to any one that it is better to pay sixty cents a gallon for disinfectant "A" than thirty cents per gallon for disinfectant "B" if "A" has four times the efficiency of "B."

To determine the cost per 100 units of efficiency of any preparation as compared to phenol, divide the cost per gallon by the cost per gallon of pure phenol; this gives the cost ratio of the two. The efficient ratio of the two is obtained by dividing the phenol coefficient of the preparation by the phenol coefficient of phenol, which is always 1, since it is the unit. The efficiency ratio is therefore always the phenol coefficient. The cost ratio divided by the efficiency ratio (the phenol coefficient) gives the cost of the disinfectant per unit efficiency of phenol. Multiplying by 100 gives the relative cost per 100 units. Thus,

$$\frac{\text{Cost of disinfectant per gallon}}{\text{Cost of phenol per gallon}} \div \frac{\text{coefficient of disinfectant}}{\text{coefficient of phenol } (=1)}$$

Cost of disinfectant per unit of efficiency compared to phenol $=1$.

Multiplying by 100 gives coefficient per 100 units of phenol.

For example, the cost of carbo-campho, with which most veterinarians are familiar, is $2.50 per gallon and has a phenol coefficient of .57; the cost of phenol is $3.25 per gallon,[1] and has a coefficient of 1. Then,

$$\frac{2.50}{3.25} \div \frac{.57}{1} = 1.33.$$

Therefore the comparative cost of carbo-campho per unit of efficiency and phenol is 1.33:1; or, multiplying by 100, we get 133:100, which means that $1.33 worth

[1]The cost of phenol is considerably higher than this at the present time, $4.95 per gallon, due to the war conditions abroad, but it was deemed best to quote the usual price rather than the unnatural one due to the present war conditions.

of carbo-campho will give as much disinfecting efficiency as a dollar's worth of phenol. Likewise, about seven cents' worth of crude carbolic acid will give as much disinfecting power as a dollar's worth of pure phenol.

Such figures as these are of value in determining the most economical disinfectant to buy, based upon efficiency and the price of phenol.

Naturally these figures will vary as the price of phenol and other disinfectants varies, so that a calculation must be made to fit market conditions as they exist. What may be the cheapest antiseptic to buy to-day may not be a month or a year hence. The following table gives figures for a number of antiseptics based upon prices to-day:

Disinfectant	Price per Gallon	Cost Ratio	Efficiency Ratio or Phenol Coefficient	Relative cost per 100 units of Efficiency Compared with pure carbolic acid
Crude carbolic acid[1]	60	.1846	2.65	6.9
Hygeno	.95	.292	3.50	8.34
Kresco (P. D. & Co.)	1.15	.353	3.92	9.00
Zenoleum	1.25	.384	2.25	17.00
Liquor cresolis compositus	2.50	.769	3.00	25.6
Trikresol	4.00	1.23	2.62	47.3
Creolin	6.66	2.04	3.25	62.7
Lysol	5.00	1.52	2.12	71.84
Carbo-campho[2]	2.50	.76	.57	133.3
Carbolic acid	3.25	1.00	1.00	100.0

In this paper we have endeavored to bring out the following facts:

1. That the fundamental principles of disinfection are based upon bacteriological facts and not upon physical appearance or odors of the disinfectant.

2. That the action of antiseptics is affected by

[1]Phenol coefficient determined at Veterinary Science Laboratory, College of Agriculture, Madison, Wis.

[2]For phenol coefficient of other disinfectants in this table, the writers are indebted to Bulletin 82, Public Health and Marine Hospital Service.

(a) Type of organism
(b) Temperature
(c) Concentration
(d) Duration of action (length of time of action)
(e) Amount and character of organic matter present.

3. That there is a method of accurately determining the bactericidal properties of any given antiseptic, known as the "hygienic laboratory phenol coefficient" method and described by Anderson and McClintic in Bulletin 82 of the Public Health and Marine Hospital Service of the United States.

4. That the phenol coefficient of any given antiseptic or disinfectant may, for practical purposes, be defined as the figure representing the ratio of the germicidal power of the disinfectant to that of carbolic acid, both having been tested under the same conditions.

5. That the only logical method of purchasing disinfectants is upon the basis of their phenol coefficients.

6. That the relative cost per unit of efficiency can be calculated by use of the phenol coefficient. That is, the relative cost of any number of antiseptics compared to carbolic acid, thus telling you just where you get the most for your money. Thus 6.9 cents will buy as much disinfecting power in crude carbolic acid as 25.6 cents spent for liquid cresolis compositus or $1.33 spent for carbo-campho or $1.00 spent for pure phenol.

ANTISEPTICS, PAST AND PRESENT, IN WOUND TREATMENT

By E. WALLIS HOARE, F.R.C.V.S., Cork, Ireland

In selecting "Antiseptics, Past and Present," as a theme for discussion, I venture to think it is one that will prove of interest to every practitioner; certainly there are many points in connection with it which offer ample room for an interchange of opinions, ideas, and experiences, the result of which is likely to prove useful in our daily work.

I freely confess that one of my reasons for choosing this subject is to ascertain as far as possible to what extent the principles of aseptic surgery can be applied to animals. I am quite aware that in certain quarters it is held that aseptic surgery can be applied to animals, and that failures in this direction are to be attributed to want of care on the part of the practitioner, or to prejudice. But in drawing conclusions on matters of this kind it is essential to possess a varied experience of surgery under conditions favorable and unfavorable, both in town and country, and one important point that I shall endeavor to demonstrate will be with reference to the effects of environment and certain unalterable conditions that exist in connection with the treatment of wounds in our patients.

PROGRESS IN VETERINARY SURGERY

I have also another object in view: many medical men and not a few of the laity hold the erroneous opinion that veterinarians do not take the trouble to practice

aseptic surgery; we are constantly asked why wounds do not heal by first intention, and why we do not adopt this or that measure which proves so successful in the case of wounds in man. For, owing to the spread of popular knowledge, the "man in the street" now professes to know something about surgical technic. Horse owners, through reading various popular works on veterinary science, pretend to know all about antiseptics, and the suggestions that are often made to us when treating wounds are grotesque in the extreme.

My remarks throughout this paper will be specially directed to demonstrate the fact that veterinary surgeons do appreciate the importance of aseptic surgery, and endeavor to carry out its principles as far as circumstances will permit.

Let us first of all take a retrospective view of veterinary surgery as applied to the treatment of wounds. That marked progress has been made is a fact apparent to even the most pronounced pessimist. This advance must be attributed to the discoveries of Lister. Although the researches of this eminent scientist were directed to the perfecting of human surgery, there is no doubt whatever but that the application of his principles to veterinary surgery has been productive of results which, if they cannot be described as brilliant, are at least most striking and eminently satisfactory. For, although abdominal surgery and the surgery of joints are, so far as the horse is concerned, as yet in a state of infancy, every one will admit that canine surgery has advanced by leaps and bounds since the principles of Lister have been applied to it. And even in the case of the horse we can justly claim that marked advance has been made through attention to Listerian principles. Again, a knowledge of the principles of wound infection has enabled us to prevent the occurrence of those fatal

sequelæ of wounds, such as septicemia, pyemia, and malignant edema, which were formerly so frequently met with following accidental and surgical wounds.

Two factors were instrumental in the erroneous treatment of wounds that previously existed. One was the lack of knowledge concerning wound infection, nothing being known with reference to micro-organisms or their effects. Another was the prevalent idea that heroic measures were essential to promote healing; hence the employment of "black oils" and similar concoctions, in sublime ignorance of the deleterious effects of irritants on wounds, and of the existence of natural means of recovery.

The researches of Lister may be said to have extended from 1865 to 1890, and it is recorded that even up to 1880 a number of eminent surgeons were incredulous as to the value of the antiseptic treatment. Hence it is not surprising to find that in veterinary surgery up to this period the Listerian principles are not universally adopted.

It may truthfully be said that, as antiseptic treatment progressed, from stage to stage, in human surgery, its value was recognized by veterinary surgeons and its principles gradually adopted. The earlier attempts at antiseptic treatment would no doubt be considered crude in the present day.

The Work of Lister

We read in the *Lancet* that in 1865-1866 "Compound fractures were treated by the local application of carbolic acid. The antiseptic was freely applied to the interior of the wounds in order to destroy the air-borne germs which had the property of causing putrefaction. The opening in the integuments was then covered with

lint charged with carbolic acid, and protected by an external layer of thin sheet metal. . . . In opening abscesses a piece of cloth from four to six inches square was dipped into a solution of one part of crystallized carbolic acid and four parts of boiled linseed oil, and then laid upon the skin where the incision was to be made. One edge of this cloth being raised, the part was incised with a knife previously dipped in the oil, and the cloth was instantly dropped upon the skin as an antiseptic curtain, beneath which the pus flowed out.

"For the subsequent dressings a kind of putty was made by mixing common whiting with the carbolized oil, and this, spread into a layer about six inches square, was laid over the incision."

From this simple and crude beginning evolved those principles which were ultimately destined to revolutionize surgery, and render their discoverer the greatest benefactor to mankind that has ever lived. In 1867, carbolized shellac plaster was substituted for the putty and found more convenient, and during the same period ligatures of silk or catgut were introduced, the latter, however, not assuming their present form until 1881. Even with the above primitive antiseptic measures a marked improvement resulted in surgical work, and Lister recorded that hospital gangrene, pyemia, and erysipelas disappeared from his wards.

In 1869 gauze charged with carbolized resin took the place of the shellac plaster, and various methods of employing carbolized oil and drainage tubes were described in articles written by Lister for the *Lancet*. In these articles were also discussed the sterilization and use of sponges, and experimental proof was adduced that "the septic ferments were solid particles and not some kind of material in solution."

The use of boric acid as an antiseptic was also de-

scribed. In 1879 improved methods of protective dressings were introduced, to prevent the carbolic acid in the external dressings from reaching the wound, once the latter had been rendered aseptic by the primary application of the antiseptic. This protective dressing was composed of oiled silk coated on both sides with specially thick copal varnish and afterwards covered with a layer of dextrin to insure its being moistened when dipped into a watery solution of carbolic acid. In cases where patients showed special idiosyncrasies to carbolic acid, either salicylic jute or gauze charged with a mixture of one part of eucalyptus and three parts of gum dammar and paraffin, were employed.

In 1881 Lister delivered two addresses containing what seems to be his first published reference to pathogenic bacteria as a distinct class of micro-organisms; and in 1883 he demonstrated the success of wiring the patella when antiseptic principles were employed. In 1884 he drew attention to the uses of corrosive sublimate as a surgical dressing. He pointed out in 1889 that sal alembroth was untrustworthy as an antiseptic, and in the same year he introduced the double cyanid of mercury and zinc as a reliable agent with which to render gauze antiseptic, but pointed out that its germicidal efficacy, or ability to destroy existing bacteria, was inferior to its power of inhibiting bacterial growth; hence it was advised that the dressing should be moistened with a five-per-cent solution of carbolic acid before being applied.

In 1890 Lister announced that he had abandoned the use of the carbolic spray three years previously, and that he had substituted a solution of corrosive sublimate for carbolic acid, having found the former less irritating and more efficient; he also pointed out that the double cyanid of mercury and zinc could be prepared in a perfectly definite manner, and although the new prod-

uct contained twice as great a percentage of cyanid of mercury as was present in the substance originally used, it had no tendency to cause irritation.

In 1907, in a note occurring in Sir Hector Cameron's book, *On the Evolution of Wound Treatment During the Last Forty Years,* we find what may be regarded as the final utterance of Lister. In this note he "advocated the use of the double cyanid of mercury and zinc. He preferred the use of sponges for the absorption of blood or other discharges from an operation wound to any of the substitutes that were proposed, while for the purification and sterilization of such sponges, with an especial view to the destruction of both the spore-less Micrococci and the spore-bearing tubercle bacilli, he preferred carbolic acid (1 to 20) to any other germicide. For purifying instruments, the hands of the operator, and the skin of the patient he used a similar solution, except in the case of the eyelids, when a solution of corrosive sublimate, being less irritating, was preferable."

In circumstances where it was impossible to exclude septic agencies, such as in operations upon the mouth or in putrid sinuses, or in certain compound fractures, iodoform might be dusted on the cut surfaces of a wound "after mopping with a solution of forty grains of chlorid of zinc in one ounce of water." The usefulness of iodoform was, however, rather limited.

In the external dressing, gauze impregnated with the double cyanid of mercury and zinc was advised, but before being applied to the wound this gauze must be rendered damp with a solution of carbolic acid.

To parts where there was very little space between the wound and some source of septic contamination, the double cyanid powder, mixed with a sufficient amount of carbolic solution (1 to 20) to form a cream, might

be applied with a camel's-hair brush. In some circumstances the cyanid powder might possibly be used as a first-aid dressing by dusting it over wounds by means of a tin with a perforated top.

"As regards the changing of dressing, when there was a free discharge from a wound he preferred, as a rule, to remove the first dressing after a lapse of twenty-four hours, but a longer interval ought to be allowed after certain amputations."

I have thought fit to give the above abridged history of the evolution of antiseptic surgery, taken from the biography of the late Lord Lister that appeared in the *Lancet*. It will assist in the consideration of what would appear to be the two schools of surgery of the present, one termed the Antiseptic, the other the Aseptic; but, as will be seen later on, the differences between them are more imaginary than real, so far as results are concerned.

Terms Defined

As already remarked, during the course of Lister's career he had to submit to severe and often unjust criticism, but this is the fate of all who attempt to leave the beaten track. One of his opponents pointed out in 1867 that Lister was not the first surgeon to use carbolic acid, but this was already admitted. It is also recorded that Sir William Savory (who was president of the Royal College of Surgeons for five years in succession, and full surgeon at Saint Bartholomew's Hospital from 1867 to 1891), at the meeting of the British Medical Association held at Cork in 1879 delivered the address on "Surgery" and spoke in attack or ridicule of the system of antiseptic surgery. I introduce this matter in order to show that surprise should not be expressed if examples of similar opposition existed among veterinary surgeons;

that such did exist I have no doubt, but at present there are few practitioners who deny the benefits of Listerian principles.

In order to comprehend the principles of the modern treatment of wounds, and to compare the antiseptic methods with those designated as aseptic, it is necessary to consider briefly the significance of certain terms that are employed in connection with the subject. Unfortunately, it happens that the same term is occasionally applied in more senses than one, or has a different meaning attached to it by various authors.

The term *septic* was formerly applied to wounds of an offensive character, which were frequently associated with septicemia, pyemia, and similar conditions. But as it is recognized now that the above conditions arise from the action of pus-producing organisms, the term septic is generally applied to all suppurating wounds.

Recognizing, however, that wounds may be offensive and distinctly unhealthy, without any evidences of the presence of pus, it is clear that septic can be applied to conditions depending on a variety of micro-organisms. In many cases the septic condition of a wound depends on one pathogenic organism, but in almost every instance ordinary pyogenic organisms are present, associated with those characteristic of sepsis.

In practice, however, we are generally inclined to apply the term septic to a putrid condition of a wound, associated or not with the presence of pus. As a large number of accidental wounds in the horse heal by granulation but not under aseptic conditions, suppuration to a varying extent is common, but the pus is not offensive, the wound tends to heal with ordinary care, and we do not apply the term septic to it, although certainly it could not be described as aseptic. As I shall point out later on, a large number of accidental wounds in horses

are already infected before the practitioner gets the chance of treating them.

Aseptic signifies the absence of sepsis—that is, the absence of micro-organisms of any kind. The term is synonymous with "sterile," or "germ-free."

Antiseptic is a term that is often loosely applied: literally it signifies anything opposed to sepsis; in a bacteriological sense, it indicates an agent that retards or prevents the development of bacteria, irrespective of its power of destroying their vitality. But it is often erroneously applied as synonymous with germicide, whereas a large number of agents classed as antiseptics are not capable of destroying pathogenic bacteria.

Disinfectant is a term applied to an agent capable of destroying infective micro-organisms, and so far as pathogenic bacteria are concerned it is synonymous with germicide. Therefore all disinfectants are antiseptics, but not all antiseptics are disinfectants.

Deodorant is a term applied to substances that are capable of destroying or removing offensive or unpleasant odors, but it does not follow that they possess disinfecting properties. Many disinfectants, however, are also deodorants.

Two "Schools" of Surgery

It will now be necessary to devote a little attention to the significance of the terms *aseptic surgery* and *antiseptic surgery.*

To such an extent has the subject been debated that two so-called "schools" have resulted, and even the are not in agreement as to the precise sense in which the term aseptic should be employed. There is in fact a decided antagonism between these schools as to the technic which is best calculated to bring about success-

ful results, for be it remembered that both aim at the prevention of infection in wounds and thus endeavor to promote healing in the shortest time possible. Briefly speaking, the aseptic system aims at preventing the access of pathogenic bacteria to wounds; it embraces all the measures adopted to keep the wound aseptic, or free from the ill effects of septic organisms, throughout its entire course. Antiseptics, except for sterilizing the patient's skin, the hands of the surgeon, or in the process of sterilizing ligatures, are rigidly excluded, and not permitted to come in contact with operation wounds. None of the materials used, such as ligatures, sutures, and dressings, contain antiseptics, but are simply sterilized. The instruments are sterilized by boiling, and are not placed in an antiseptic solution.

Of course, the aseptic method can be applied only to operation wounds made through unbroken skin into non-infected tissues. The disciples of the aseptic school term the methods in which antiseptics are employed, either in solutions or dressings, as antiseptic methods. Some even go further than this, for we find one surgeon, Mr. Burghard, stating that the term antiseptic, when applied to the treatment of wounds, "should be reserved for those measures designed to combat sepsis already present in a wound."

The antiseptic school, however, claim that their methods are also aseptic, although as a means of precaution they employ antiseptics in addition to the means of securing asepsis. Sir Watson Cheyne, one of the advocates for this method, states:

"Aseptic surgery is the method of treatment directed to the maintenance of an aseptic condition in the tissues of the wound presumably existing at the time of operation. . . . But on the other hand, antiseptic surgery has to deal with tissues which have already been

infected, with or without a breach of the surface, and here the surgeon's efforts are directed to diminishing the effects of already existing sepsis, or it may be in a few cases even to eradicating it."

Mr. Lockwood, who steers a middle course, says in his work on *Aseptic Surgery,* "Any method of wound treatment which aims at sterility will be called aseptic."

The "bone of contention" between these two systems would appear to be the question of the employment of antiseptics; those of the aseptic school holding that these agents, by causing irritation, interfere with the normal powers of resistance of the tissues, and thus retard healing. This weakening of the resisting power of the tissues may even enable micro-organisms to enter and take effect, in cases where surgical cleanliness was neglected, although antiseptics were employed.

Sir Watson Cheyne, however, points out in the *Bradshaw Lecture on the Treatment of Wounds* (1908), that the Listerian principles in wound treatment include two important postulates:

1. Exclusion of bacteria especially of pathogenic organisms, as far as possible during and after an operation.
2. Avoidance of irritation of the surface of a wound, so as not to interfere with healing or with the powers of the tissues, to prevent the growth of any bacteria which have entered.

This authority clearly explains that, by the Listerian system, every precaution is taken to prevent irritation from the antiseptics employed, and also states that, even with adherence to the strict principles of the so-called aseptic system, suppuration has occurred when operations were carried out in regions other than the peritoneum. He believes "that of late many surgeons have gone to extremes in the avoidance of antiseptic solution," and that the aseptic system, so called, is "only carrying to an extreme the principle of avoiding irri-

tation of wounds." He also shows that even the application of plain boiled water to the surface of a wound interferes with the integrity of leukocytes and other cells, for under the microscope they are found to swell up rapidly and become completely disintegrated. In summing up his criticism he states that "the pendulum has swung too far in the direction of the avoidance of antiseptics, and that the reasonable use of all the means at our disposal for securing asepticity of wounds will furnish more constant results." He also adds: "The chief point to which I take exception is the employment of dressings which do not contain an antiseptic in sufficient amount to render the discharges which flow through them unsuitable for the growth of bacteria." When a dressing not containing an antiseptic, although sterile, becomes soaked with discharge, the latter may remain sterile until it comes near the surface of the dressing, but then bacteria will grow into and rapidly spread through it and reach the wound, unless the blood has in the meantime become so concentrated by drying that it is no longer a suitable cultivating medium.

A second point is the absence of antiseptic solutions during the operation, in which hands and instruments may be washed from time to time to insure continued asepsis. "The attempt to treat wounds without any antiseptics is a very unnecessary complication. In the first place, it is ever so much more difficult to secure asepticity of a wound under such circumstances than if one takes advantage of antiseptics, and in the second place it requires a man who is especially skilled in bacteriological work, to bear in mind the various loopholes which have to be guarded against in order to obtain a constant aseptic result. . . . I confess that I can see no reason for this great dread of a drop of antiseptic material getting into a wound; I can only say that my own

results, and those of surgeons who use antiseptics judiciously, are in every way as good as those obtained with the more elaborate aseptic precautions; in fact, seeing that we are not troubled with sepsis or stitch abscess at all, I venture to assert that they are better, because they are more constant and dependable."

Rose and Carless, contrasting aseptic and antiseptic surgery, in their *Manual of Surgery* state:

"It is only natural that we who have had the privilege of working with Lord Lister, and have seen the excellent results following the intelligent use of antiseptics as mapped out above, should still cling to that line of practice which certainly can be carried out with more precision under all circumstances, both in private and hospital, than the other plan, the objects of which may at any moment be defeated by some slight inadvertence or oversight. The theory of asepsis is no doubt perfect, but its practical application is often difficult owing to the necessity of having sterilizers always at hand, a matter almost impossible in cases of emergency, in private practice."

Measures Attempted

I have deemed it advisable to quote the opinions of the above eminent surgeons on the subject of aseptic and antiseptic surgery before proceeding to consider how far the principles can be applied in veterinary surgery. I shall endeavor to show that, although in the case of the dog it is possible to carry out perfect aseptic principles under proper surroundings, it is a far different matter when we come to deal with equine surgery. I suppose it will be generally admitted that in the treatment of wounds in horses there are certain important indications to be fulfilled.

Measures should be adopted which are likely to insure the healing of wounds in as short a time as possible, so that the animal can return to work.

Steps should be taken to prevent serious complications such as septicemia, pyemia, malignant edema, erysipelas, bacillary necrosis, and tetanus.

Measures for the prevention of permanent blemishes are of importance, and in the case of wounds affecting the limbs, every effort should be made to avoid the occurrence of conditions likely to interfere with the working powers of the animal.

Human and Veterinary Surgery Contrasted

Here it will be necessary to compare human surgery and veterinary surgery as regards the treatment of wounds, both accidental and as the result of operations. The distinguishing features that stand out pre-eminently are the following. The human surgeon has the advantage of a well-equipped hospital with all modern conveniences, and a staff of trained nurses to carry out his instructions. He is supplied with every detail calculated to insure surgical cleanliness and to exert a favorable influence on the course of wounds. Moreover, in operation wounds, aseptic principles are carried out from start to finish by trained hands, and the patients contribute to favorable results by obeying the instructions of the surgeon. By complete rest the healing of wounds is facilitated, and means can be adopted by which the affected part is rendered as free from movement as possible.

In the case of accidental wounds, early treatment is carried out before sepsis has had time to exert its effects, even though micro-organisms have gained an entrance.

The veterinary surgeon, on the other hand, has the most

adverse circumstances to contend with in his endeavors to render wounds, whether surgical or accidental, aseptic, and to keep them in this condition. Even in the best equipped veterinary infirmaries, so far as horses are concerned, it is extremely difficult to carry out aseptic surgery. No doubt by the use of iodin it is now possible to sterilize the skin, but there are other points to be considered.

Given an operating table, and a trained staff of assistants, so that the operator is concerned only with the operation, and the certainty that the operator or his assistants will carry out the subsequent dressings of the wound, then indeed aseptic surgery and healing by first intention are possible, provided the technic is carried out so that the entry of micro-organisms is prevented.

Hindrances to Aseptic Surgery

But in ordinary practice a very different state of affairs exists; the patient is cast on a bed of straw, skilled assistants are not at hand, so that the operator has to attend to the casting, securing, and so forth, of the animal, by which means his hands become contaminated, and even the best directed attempts at asepsis are likely to be frustrated by the clumsy actions of the assistants. Then again, unless the practitioner is able to carry out the after-treatment of the case, his primary endeavors will fail, as contamination of the wound is certain to occur.

With reference to accidental wounds, it is quite apparent that they become infected before professional assistance is sought. Contamination occurs at the time the injury is inflicted, and also from the treatment adopted by the owner or attendant.

Consider also the surroundings in which horses are

placed; even with the most scrupulous care and attention, it is impossible to render the best planned stall free from micro-organisms, and every act of the attendant seems calculated to secure infection of the wound. As for the average stable, both in town and country, and the crude methods of treatment adopted by the owners of animals, the wonder is that serious or fatal sequelæ are not more common. For not only is the stall a veritable breeding ground for micro-organsims, but also everything brought in contact with the wound is teeming with germs. Hands begrimed with dirt, filthy sponges, dirty stable buckets, and soiled bandages are much in evidence, while often even the water for performing the perfunctory cleansing of the wound is anything but pure. How, then, do wounds heal under such circumstances? I think you will agree that the explanation is to be found in the natural powers of resistance possessed by the horse. If this vital resistance to the action of micro-organisms did not exist, we should meet with far more cases of septicemia, pyemia, and similar conditions, than we do at present.

No doubt of late years it is not unusual to find disinfectants in the hands of many owners of animals, and these agents are applied to wounds in concentrated solutions with a total disregard for ordinary cleanliness. The result is that instead of promoting healing they retard it, as they exert a caustic and irritant action on the tissues. At the same time the deeper portions of the wounds are not cleansed and abound in micro-organisms.

A similar error is committed with reference to the disinfection of stable floors, the dirty surface being allowed to remain while disinfectants are scattered thereon.

Then again, while wounds are being dressed it is not uncommon to find the dressings laid on the stable floor

for convenience and thus exposed to contamination from several sources.

Varieties of Wound Infection

It will now be of advantage to consider as briefly as possible the measures that can be adopted in order to fulfill the indications I have mentioned. In order to fully grasp the importance of attention to surgical cleanliness, and the judicious employment of antiseptics in the treatment of wounds, it will be necessary to consider the *micro-organisms of wounds,* the *modes of infection,* and the means by which these can be overcome.

With reference to micro-organisms, the most important are the pyogenic cocci; these include the following Staphylococci and Streptococci:

Staphylococcus pyogenes aureus is found in acute abscesses and is responsible for the majority of suppurative inflammations. It is occasionally present in general pyemia, and is often associated with other pyogenic organisms in suppurative processes. It is very resistant to many antiseptics, but is readily detroyed by solutions of the more powerful germicides; it is very widely distributed, and is found abundantly in the superficial layers of the skin of animals and frequently beneath the fingernails in man. Experiments have demonstrated its power of producing suppuration, both locally and internally, and it has been shown that if the vitality of the parts experimented on has been previously lowered, or the tissues damaged by chemical or mechanical means, infection occurs more certainly and readily.

Staphylococcus pyogenes albus is similar to but far less virulent in its action than S. aureus.

Staphylococcus pyogenes citreus is found only in abscesses.

Streptococcus pyogenes is another very important organism. It is the causal agent in spreading cellular inflammation, and of pyemia and septicemia in many instances; also of septic metritis, and ulcerative endocarditis. One of its peculiarities is its tendency to invade the lymphatics and to induce lymphangitis and cellulitis; another is its capability of producing acute suppuration, sloughing of the tissues, and inflammatory wound-gangrene. Probably there are many varieties of Streptococci, but their characters resemble each other so closely that it has not been possible to isolate them. Thus the S. erysipelatis, the causal agent of erysipelas, resembles so closely, both in appearance and cultural characters, the S. pyogenes, that many authorities regard them as identical. The effects produced, however, are rather distinctive, and the S. erysipelatis must be regarded as an organism of serious importance in connection with the treatment of wounds.

The powers of resistance of Streptococci must be regarded as feeble when compared with those of Staphylococci.

Bacilli of importance in connection with wound infection are the *tetanus bacillus,* the *bacillus of necrosis,* (B. necrophorus), the *bacillus of malignant edema,* and the *bacillus coli communis.* Occasionally the *bacillus tuberculosis* and the *bacillus* (Pseudomonas) *pyocyaneus* may infect wounds. Among other causal agents in wound infection we may mention the *Botryomyces* and the *Actinomyces,* also the Streptococcus equi, the causative factor in strangles or colt distemper.

With such a formidable list of micro-organisms before us, it is apparent that the most important part of our duties in connection with the treatment of wounds is to prevent the entrance of these microbes so far as is possible, or, failing in this, to destroy their vitality or retard or prevent their development.

The following modes of infection merit consideration:

1. Infection by Air.—Aerial infection was recognized even in prescientific periods. The Listerian principles and the carbolic spray were directed against this mode of infection, and the air was regarded as containing the germs of putrefaction, which were capable of setting up septic processes in wounds and their secretions. This view has been considerably modified in the present day. Experiments have demonstrated that the greater number of bacteria present in the air are non-pathogenic, that germs exist in the atmosphere only in the form of dry dust, that air perfectly freed from dust is harmless to wounds, and when the air is kept still, wound infection rarely takes place through the atmosphere. But when we consider the surroundings of horses, the dust raised from a straw bed and during the process of cleaning the stall, we must admit the possibility of infection by air containing dust. Indeed, some observers state that they have found cocci closely related to the pyogenic varieties, and sometimes actually belonging to that class, in atmosphere dust, especially when the air is moist.

2. Infection by Water.—Infection by means of the water used occurs unless this fluid is sterilized by boiling or a germicide is added thereto. Ordinary water contains a large number of bacteria, usually many hundred thousand per cubic centimeter.

3. Miscellaneous Sources.—Other modes of infection include infection from the skin of the patient, from the hands of the surgeon or those of his assistants, from instruments, sponges or their substitutes, ligatures and sutures, dressing materials, vessels or utensils, syringes, and in other ways.

Circumstances Predisposing to Infection

Among the factors which render a given infection more likely to prove harmful is excessive injury to the

tissues during an operation, such as rough manipulation or bruising or tearing of the structures. By these means the vitality of the tissues is lowered and their resistance so impaired that the development of micro-organisms which may have gained entrance is thereby favored. The number and virulence of the infecting organisms, the state of health of the animal, and the environment are also important in connection with this subject.

Wound Healing

Time will not permit me to enter into the question of the repair of wounds. As you are well aware, the modes of healing are as follows:

1. Primary Union or "Union by First Intention."—This takes place in simple incised wounds under favorable conditions—that is, when there is a practical freedom from infection, when hemorrhage has been arrested, and the surfaces are brought into apposition and kept at rest. It is the mode of healing we will strive to bring about but so seldom succeed in attaining when the horse is concerned.

2. Union by Granulation and Cicatrization.—This is by far the more common method of healing in horses. Formerly there was an idea that the suppuration accompanying the process originated from the superficial layer of cells on the recent granulations, which were arrested in their development and converted into pus cells, being cast off in the discharge. We know now that the cause of the suppuration is the presence of micro-organisms, and that union by granulation can occur without suppuration, although admitting that such is not common in the horse.

3. Union Under a Scab.—In this, repair takes place beneath a scab formed by the drying of the discharges. This is cast off spontaneously as soon as cicatrization

is completed underneath. It is a common mode of repair in wounds left to heal without any dressing.

The Technic of Treatment

We now arrive at the practical application of the principles, based on a consideration of the points we have considered. Dealing first with operation wounds, in the case of healthy tissues in the normal animal, there are certain details which, if they do not result in bringing about healing by first intention, will at any rate assist in the process of repair, and prevent the occurrence of serious sequelæ.

I suppose every one will agree that instruments are best sterilized by boiling for five minutes in water containing a teaspoonful of carbonate of soda to each pint. The addition of the soda raises the boiling point of water to 104 degrees Centigrade, and also prevents the formation of rust if the instruments are left in the solution for some time; when required for use they are placed in a sterilized tray containing a solution of carbolic acid (1 to 40). The water should be boiling before the instruments are placed therein, and the vessel in which they are boiled should have a closely fitting lid so that the water will boil at a uniform temperature. As regards sharp instruments, such as knives, scissors, and needles, which become blunt from the effects of boiling, some surgeons advise that the edges be protected with a piece of gauze or lint, and state that blunting does not then occur. This is not my experience, and I prefer to immerse such instruments in undiluted carbolic acid for a short time, and then place them in a carbolic solution (1 to 20). This method is advised by Sir Watson Cheyne, and it is also valuable in case an instrument happens to fall on the ground during an operation and is immediately required, since boiling takes five min-

utes to sterilize, Indeed, this method is also useful in emergency operations, when facilities for boiling are not at hand, or an instrument is required for use at a moment's notice. Corrosive sublimate has a most destructive effect on metallic instruments, therefore solutions of this agent are unsuitable for sterilization purposes.

As regards the preparation of the patient's skin and the hands of the surgeon, it is not feasible to carry out that tedious technic of sterilization adopted by human surgeons. Fortunately we have in tincture of iodin an agent which renders the skin of the patient and the hands of the operator aseptic. Of course the operation area should first be shaved before the iodin is applied. Two applications are necessary, one about fifteen minutes prior to operation and the other immediately before the operation. Simple incised wounds are those which are most likely to heal by first intention, provided certain details receive attention.

Primary Union Seldom Secured

Deeper wounds, as already remarked, generally heal by granulation, but unfortunately in too many instances suppuration occurs in spite of all precautions. But there are degrees of infection depending on the number, character, and virulence of the infecting micro-organisms that gain entrance to the wound; hence the necessity for surgical cleanliness and the judicious employment of antiseptics.

There are two important points in connection with the subject which cannot be ignored. The first is, that in operations of all kinds the tissues should receive as little damage as possible. Neatness and dexterity in operating exert a marked influence on the healing of the resulting wounds. This is well exemplified in the operation of neurectomy, when a skillful operator exposes the

nerve and excises the desired portion with little or no damage to the surrounding tissues. On the other hand, an inexpert operator, in his efforts to expose the nerve, disorganizes the tissues to a considerable extent. In the former case the wound heals by first intention; in the latter, even with all attempts at asepsis and antisepsis, healing occurs by granulation often accompanied by suppuration.

The next point is with reference to drainage. Now in all wounds of any extent an exudation of serum occurs, generally referred to as the "secretions of the wound." Such must not be allowed to accumulate in spaces in the wound, and proper drainage is necessary. Accumulations of serum not only cause tension in the wound, but also favor the growth of micro-organisms.

The various details in connection with aseptic wounds need not occupy us further. For the reasons already given, in the case of horses it is difficult to obtain healing by first intention; that it is possible even in the major operations has been demonstrated by operators who have had special opportunities for carrying out the technic. But I have yet to learn that aseptic surgery, as conducted by human surgeons, can be carried out in the ordinary operation by the general practitioner. Take even the latest surgical feat, the new operation for "roaring," where aseptic precautions are rigidly carried out before and during the operation, and what is the result? Certainly not healing by first intention in any instance, and more often than otherwise the wound is septic and frequently fetid. Such a condition would be regarded as anything but creditable in human laryngeal surgery—but then the circumstances are different.

There are some enthusiasts who give details of aseptic methods of castration; needless to say, they do not operate on many colts and have very little idea of the condi-

tions and environment of these animals in the country. My experience in the attempt I made at aseptic castration carried out by means of ligature was that no suppuration or swelling occurred, but the animal died of septicemia and septic peritonitis. Had suppuration and swelling occurred, probably the case would not have resulted fatally. At the same time I believe in all possible attention to surgical cleanliness and to antisepsis during the operation of castration, although I know full well these measures will be frustrated in their results by the owner or attendant of the animal. How infection occurs in castration wounds is so obvious that I need not refer to the subject.

Treatment of Accidental Wounds

When operation wounds suppurate or become septic, they are in the same category as accidental wounds so far as treatment is concerned.

Every accidental wound may be assumed to be infected, to a greater or less extent.

In carrying out treatment, there are certain important procedures necessary, which I shall refer to under the following headings:

1. Arrest of Hemorrhage.—In order to be able to explore a wound with any degree of accuracy, to say nothing of checking preventable waste of blood, hemostasis is of prime import. This is to be accomplished by means of torsion or compression of all bleeding vessels or by ligation.

2. Cleansing and Disinfecting of the Wound.—This is carried out by careful washing with an antiseptic solution. As to the agent selected it is largely a question of choice. The large number of reliable germicides that are now on the market render a selection comparatively easy. Carbolic acid is still largely

employed for the purpose, although there is considerable difference of opinion as regards its germicidal power. Whatever agent is used, a thorough cleansing of the wound is essential.

Unfortunately, we do not often get the chance to attend to the first dressing of a wound, as the owner or the attendant attempts the process on the occurrence of the accident and far too frequently introduces infection. In the case of a deep punctured wound, in which infection is probably deep-seated, and the external opening small in size, it is necessary to carefully enlarge the latter so as to carry out thorough irrigation.

3. Removal of Foreign Bodies.—This is a procedure that requires special attention. Wounds in hunters frequently contain foreign bodies such as thorns, portions of gravel, or other substances, and a careful search is necessary in order to discover their presence; if they are overlooked, serious trouble will occur afterwards.

4. Drainage.—Efficient drainage is of the greatest importance. This is well exemplified by contrasting the progress made by punctured wounds extending in an upward direction, with those extending downwards. Without proper drainage, all other means will fail. To carry this out efficiently in the case of extensive wounds is not always an easy matter, but on it depends success or failure. Suitable openings must be made at dependent parts, and the selection of drainage materials will depend on circumstances. If gauze drainage can be employed, care should be taken that the gauze does not act as a plug and prevent the escape of discharge. In extensive wounds, india-rubber drainage tubes are to be preferred. The old-fashioned seton must be condemned, as it causes irritation and increases suppuration.

5. Sutures.—Careful consideration is necessary in order to decide whether it is advisable to employ sutures.

The frequency with which extensive wounds involving the muscular tissues (such as occur in the region of the hip) suppurate, and the sutures give way, has led some practitioners to leave such wounds open. No doubt in the case of a "squealing," kicking mare, or of an unbroken colt, we all have a tendency at times to avoid the use of sutures, and it is surprising to find how readily such wounds heal. Still, there is no doubt but that less blemish is left if the edges of such wounds are brought together by sutures, at any rate for a time, provided thorough cleansing is carried out and proper drainage provided. In extensive wounds of this kind occurring in vicious animals, I always cast the patient in order to carry out the procedure properly. The suture material should be soft in texture, but strong; hard material is very likely to cut through the skin. In clean-cut wounds, sutures should always be employed. It is hardly necessary to remark that in punctured wounds, or deep wounds of any kind, and in the case of torn or lacerated wounds with much destruction of tissue, or in suppurating or septic wounds, sutures are contraindicated.

Experience has taught me that wounds in the region of the head are best treated without sutures, unless such cases are in an infirmary under the immediate care of the practitioner, so that the early indications of septic infection may be observed. Under other conditions there is a tendency to the occurrence of erysipelas or allied complications. I now paint such wounds with tincture of iodin and find the best results therefrom. This may be considered as an irritating agent, but the results justify its employment. There are instances of suppurating wounds in which suturing should be attempted in order to avoid permanent blemish. Some time ago I saw a case in a foal in which a wound extended

from the commissure of the lips up the cheek, exposing the first two molar teeth. The accident had occurred about ten days previously, and two attempts at suturing had been made, but they were unsuccessful. The wound was suppurating freely and granulations had formed on each of the edges, but there were no evidences of union. My first attempt was also unsuccessful. I then cast the animal again, removed all granulations with sharp scissors, freshened the edges of the skin and mucous membrane, removed all debris of food, washed the parts thoroughly with peroxid of hydrogen, inserted a deep layer of sutures so as to bring the edges of the mucous membrane together, the sutures being composed of soft silk soaked in peroxid of hydrogen, a superficial row of sutures was inserted in the skin, the wound was again cleansed with the antiseptic, and then painted over with collodion. The foal was removed from the dam and fed from a pail, and no further dressings ordered except the application of compound tincture of benzoin to the edges of the wound after a few days. A few of the sutures gave way, but healing progressed satisfactorily and perfect union resulted.

6. Surgical Dressings.—As a general rule, wounds should be covered with suitable surgical dressings whenever possible, at any rate in the earlier stages. Whether these dressings should be moist or dry must depend on circumstances. In suppurating wounds I find the best dressing, in cases where expense is no object, is double cyanid gauze soaked in a solution of peroxid of hydrogen (one part of the ten-volume solution to three of water). The gauze is then enveloped with a thick layer of cotton wool and a bandage.

As to the frequency of dressing, this will depend on the amount of discharge. When the latter soaks through the dressing, it is an indication for renewal. If this

be neglected the discharges become putrid and a mixed infection is likely to occur.

For country practice a reliable and cheap antiseptic is *Huxley's Liquor Cresolis,* in two-per-cent solution.

As the discharge lessens, the dressing need not be changed sooner than the third day, and later on a dry antiseptic dressing, such as boric acid with zinc oxid, may take the place of the moist one.

In punctured wounds, after drainage has been provided for I find it is a good plan to plug the wound with gauze soaked in peroxid of hydrogen. This dressing may be renewed as often as circumstances require.

In country practice it is useless to expect the owner or attendant to apply dressings properly. Therefore, unless there are reasons to the contrary, wounds do best when left open, being simply cleansed with an antiseptic solution and painted with compound tincture of benzoin. This latter agent fell into disuse for a time, but in my experience it is a most useful wound dressing for country cases, where as little handling of the wound as possible is an important matter.

Carbolized oil, which at one time was so popular a dressing, is now known to be absolutely inert as a germicide.

In hunters, deep puncture wounds of the front of the hind fetlock due to sharp stones are of frequent occurrence. The bursa of the tendon may, or may not, be opened, but acute inflammation rapidly develops and marked pain is present. Attempts to heal such wounds quickly do not prove successful, as infection is deeply situated; in my experience the best dressing is one of the modern substitutes for poultices, which are composed of kaolin, glycerin, and antiseptic agents, applied hot and changed daily. When acute symptoms have subsided, the ordinary dressings may be applied.

Wounds of the sheaths of the flexor tendons are often serious in consequence of the infection extending upward and downward. Free drainage should be provided early, and rigid attention to antisepsis is necessary.

In all wounds in the region of the limbs there is a tendency to the formation of exuberant granulations. These require early attention in order to avoid permanent blemishes. I find that the judicious application of finely powdered sulphate of copper is the most reliable treatment in these cases, old fashioned no doubt, but efficient for the purpose required.

Wounds of the knee, involving the extensor tendons in the vicinity of this joint, are not uncommonly followed by fibrous ankylosis, accelerated no doubt by keeping the horse from lying down. When such a complication occurs, the animal should be cast and chloroformed and the joint forcibly flexed, otherwise the horse will be useless.

Wounds in the feet due to picked-up nails I shall not consider here, as this would form a separate subject for a paper. But in hunters, wounds are not uncommon in this region as the result of portions of furze (gorse) branches entering the foot in the vicinity of the frog. Sharp portions of flint not uncommonly enter the foot and extend deep into the sole. The detection of such foreign bodies is not always an easy matter and requires a careful examination of the foot. I believe the best treatment, after the removal of the foreign body and the proper enlargement of the wound, is to apply pure carbolic acid or lysol, and a cataplasm composed of kaolin and glycerin.

In my experience the most dangerous wounds are those due to punctures from shafts, such as result from collisions. The difficulty in obtaining drainage is very considerable, especially when the wound occurs in the

region of the hind quarter. But proper drainage must be secured at all costs, otherwise treatment will fail and septicemia result. If necessary, the animal should be cast in order to carry out the surgical procedure; after-treatment will consist in copious irrigation with antiseptic solutions carried out by means of a Winton's syringe provided with a gum-elastic top. Where expense is not objected to, the wound should be plugged with double cyanid gauze soaked in hydrogen peroxid solution, the irrigation and dressing being carried out daily.

Time will not permit me to deal with the question of open joints, which in reality would require a special paper. But I cannot omit drawing attention to the dangerous character of punctured wounds in the forearm, which are not uncommonly followed by purulent arthritis of the elbow joint. The septic inflammation extends along the sheaths of the tendons, and these tendons support directly the synovial membrane of the elbow joint. Hence wounds of this region should be drained as early as possible by a free dependent opening.

Conclusion

The practical outcome of a consideration of the subject appears to be that, although we can never hope to practice aseptic surgery in the strict sense of the term, we can at least carry out antiseptic principles, so far as is possible under the very unfavorable conditions that surround us.

Improvements in the results obtained are more likely to follow strict attention to surgical cleanliness and proper drainage of wounds than care in the selection of the agents we employ as drainage. After twenty-five years of "playing the game," and seeing it played by

others, I cannot believe that among the host of agents that are introduced yearly, one possesses any special virtues over another so far as the healing of wounds is concerned.

In conclusion, I think the practical deduction to be drawn is that every attempt should be made to exclude infection from wounds, whenever this is possible, and, in the case of wounds already infected, to retard the growth and development of micro-organisms by the judicious employment of antiseptics.

But whether in the case of operation or of accidental wounds, it is quite apparent that in ordinary practice we cannot dispense with antiseptics, and attempts to do so are likely to be followed by disaster.

SUPPRESSION OF HEMORRHAGE

By E. WALLIS HOARE, F.R.C.V.S., Cork, Ireland

The arrest of hemorrhage is one of the most important points in connection with the technic for the treatment of both surgical and accidental wounds. There are two reasons why hemorrhage should be controlled:

1. To prevent a fatal termination from excessive loss of blood.
2. Hemorrhage lowers the vitality of the animal's system and hence retards the healing of wounds. Also blood clots in a wound form a nidus for the development of micro-organisms.

Fatal hemorrhage, so far as wounds are concerned, occurs when a large blood vessel is severed and professional assistance is not at hand. But it may result, in spite of the efforts of the practitioner, when one or more large vessels are severed that are so deeply situated they cannot be ligated. This may occur in the case of extensive wounds due to the penetration of a shaft between the forearm and the chest, or at any part of the pectoral region, or in the vicinity of the inferior aspect of the neck.

In such cases but little time is allowed for the efforts of the surgeon to prove successful. Very often more than one vessel is severed, and unless ligation can be employed without delay, a fatal termination will result. Plugging the wound with tow is of little or no use when the hemorrhage proceeds from a large vessel. In my experience the only plan that offers any chance of success is to insert a temporary plug of tow and to cast the animal immediately, then seek for the bleeding vessel

(enlarging the wound if necessary), and, having secured it with an artery forceps, apply a ligature. In some instances it may not be necessary to cast the horse, as in consequence of the loss of blood he does not resist the necessary manipulation, but the procedure is far more easily and satisfactorily carried out when the animal is in the recumbent position.

As already remarked, all our efforts may fail in cases where the vessel is out of reach. Plugging with tow may succeed when the wounded vessel is not of large size, but even in this case it is not to be advised. Although such plugging may temporarily arrest the hemorrhage, there is always the risk that secondary bleeding will occur and prove fatal in the absence of the attendant. It may be laid down as a rule that ligature is the only safe method to adopt in the suppression of hemorrhage. Only when the vessel cannot be secured should resort be had to plugging the wound.

It sometimes happens that although a vessel may be secured by the artery forceps, in consequence of its depth a ligature cannot be applied. In many instances, by the employment of Schoemaker's pattern of forceps, in which by means of a groove at the point of one of the blades a ligature is held in position, a deep-seated vessel may be ligated. This is a most useful instrument and should be in the possession of every practitioner.

I have frequently left an artery forceps *in situ* for twenty-four hours in cases where a ligature could not be applied. Care should be taken to tie up the animal during the interval so that he may not lie down and so cause the instrument to become detached, or to be driven inward by pressure.

In preparing for major operations, a plentiful supply of artery forceps of large and small sizes should be provided, as one never knows when a large vessel may

be severed. There are so many patterns of these instruments now on the market that a selection of the best is not an easy matter. Personally, I prefer the pattern known as the Mayo-Ochner, which is of the "rat's-tooth" type and very efficient. For ease in getting the ligature to slip down the forceps, Greig-Smith's pattern can be recommended, and the larger sizes are especially useful for ligating large vessels.

As to the ligature material, some prefer silk, others catgut, but I prefer the material known as "Chinese twist," which can be obtained in all sizes, can be readily sterilized, and stands great strain. Nothing is more annoying when ligating a vessel than to have the ligature material break at a critical moment.

In the case of small vessels, where no ligature is required, I have found that Blunk's hemostatic forceps are convenient and reliable.

Tumors

There are certain operations in which the question of the arrest or control of hemorrhage is of special importance. Tumors in the region of the shoulder, also known as "collar" tumors, in some cases depending on the presence of Botryomyces but in others having a doubtful etiology, need special care.

When ordinary treatment fails—that is, locating the abscess by means of a trocar and cannula, free incision, curetting the cavity, and plugging with tow soaked in tincture of iodin—then excision must be resorted to.

A knowledge of the anatomy of this region, and of the firm consistency of the tumor and its extensive attachments, indicates that serious hemorrhage is likely to occur unless care be taken in the technic of the operation. The position of the carotid artery should be carefully noted, so as to avoid injuring this vessel. But in my experience the vessel which is most likely to be

severed is the ascending branch of the inferior cervical artery. In many instances I have located and ligatured this vessel prior to incising the parts in the vicinity and thus saved much subsequent trouble and time. And here I may remark that in every instance and in every region when we come across a vessel that is likely to be severed during the operation, it is a good plan to ligature it before proceeding further.

Large pressure forceps are useful to hold deep-seated portions of the tumor. The growth is severed along the edge of the forceps, and any vessels that are cut can be seen and readily secured before the structures are let go.

After the tumor has been removed, and all bleeding points secured, I advise packing with carbolized tow in order to combat any danger of secondary hemorrhage. Healing by first intention is not to be expected, and the packing can be removed within twenty-four hours. I have met with very serious secondary hemorrhage from cases of this kind, and hence I find that firm packing immediately after operation is the best plan to adopt.

When secondary hemorrhage does occur, it is very difficult to suppress; these tumors have such extensive vascular attachments that bleeding may be very profuse, and when it occurs at night time, and is not immediately observed and checked, a fatal result may ensue. In the case of a quiet animal, the bleeding vessel may be located and secured, but otherwise it may be necessary to cast the patient in order to carry out the necessary procedure.

In less severe cases, firm plugging with tow and deep suturing of the edge of the wound will prove successful. In the case of all wounds the great objection to firm plugging is the extensive swelling that usually results, therefore I always prefer, when possible, to secure the

bleeding vessel. Moreover, there are instances in which the hemorrhage recurs after the packing is removed, and as a result the cleansing of the wound cannot be properly carried out.

Castration

Why hemorrhage occurs in some cases after castration and not in others, when the measures adopted to secure the spermatic artery are similar in each instance, is a problem which is not easy to solve.

Generally speaking, the most serious and annoying cases are those that occur some time after the operation, say within twelve or twenty-four hours. As my experience of castration cases is limited to those operated on by torsion, I can deal with the subject only from this point of view. This experience has taught me that in the vast majority of cases, if torsion is properly carried out and the spermatic artery is in a healthy condition and the animal healthy, hemorrhage does not occur. The exceptions are those cases in which we cannot account for the hemorrhage.

The procedure to be adopted depends on the extent of the bleeding. We frequently observe cases that bleed profusely after getting up, but this soon ceases without any treatment. Obviously, such do not depend on hemorrhage from the spermatic artery, but the bleeding arises from the artery of the cord or from a vessel in the scrotum.

When the hemorrhage is profuse and clearly arterial, the best plan is to cast the animal, seek for and secure the severed end of the spermatic cord, and apply a ligature. This is far preferable to plugging the inguinal canal and scrotal cavity with tow, with its risks of secondary hemorrhage when the packing is being removed, and the extensive swelling which always results. In the

case of secondary hemorrhage occurring at night, plugging with tow may be the only practicable measure to be adopted under the circumstances.

In the after-treatment care should be taken to remove all blood clots, for otherwise a septic condition is likely to result. It must be admitted that in many cases the hemorrhage after castration ceases spontaneously. The measures adopted, such as throwing cold water over the loins or applying cloths soaked in cold water to the same region, are of doubtful efficacy.

That "weedy" debilitated colts are most subject to this variety of hemorrhage is well known. Again, aged donkeys and mules are very apt to bleed profusely unless special care is taken in the performance of torsion of the artery.

I have often observed that castration performed under deep chloroform anesthesia is likely to be followed by hemorrhage some hours afterwards. This does not occur when a lighter degree of anesthesia is employed.

Epistaxis

Hemorrhage from the nose occasionally gives rise to considerable trouble, especially when arising from injuries about the facial and nasal region. As it is dangerous to plug both nasal passages of the horse, this method of suppressing the hemorrhage is not practicable. If one nasal passage only be plugged, the blood finds its way down the other.

Local injection of adrenalin proves useful, and raising the horse's head will also assist in controlling the hemorrhage, but care must be taken lest the blood gain entrance to the trachea.

Accidental Wounds

I have already referred to the question of hemorrhage arising from injuries due to shafts penetrating the body.

But there are many minor injuries in which hemorrhage may be a troublesome feature. Wounds received during hunting furnish a large number of cases in sporting districts. In these the same golden rule applies: *always secure and ligature a bleeding vessel whenever possible.* Avoid plugging and tight bandaging except as an emergency measure.

As regards hemostatic agents, they have no effect in the case of vessels of any size, and the majority of them irritate the wound.

Deep punctured wounds, in which it is not possible to secure a bleeding vessel without making an extensive opening, may be plugged with antiseptic gauze.

Wounds involving the digital arteries in the region of the coronet are often troublesome, as it is by no means easy to secure the bleeding vessel, especially in the case of a nervous, excitable horse. The Mayo-Ochner artery forceps will be found useful for cases of this kind.

When an artery or vein is exposed in an extensive wound, but not severed, it is advisable to apply a ligature, since the walls of the vessel may give way and serious hemorrhage result. Should it become necessary to apply a ligature to the carotid artery it must be remembered that in consequence of the collateral circulation both the proximal and the distal ends of the vessel must be secured.

As regards the employment of the actual cautery as a hemostatic agent, in consequence of tissues it produces it is now being discarded. In Great Britain it is still employed by some practitioners in the operation of castration and also docking. From a humane and scientific point of view it is to be hoped that the suppression of hemorrhage by means of the actual cautery will soon be regarded as one of the relics of the barbarous ages.

TREATMENT OF WOUNDS

By L. A. MERILLAT

The treatment of wounds! What a vast subject! When the surgeon makes a wound, or meets one accidentally inflicted, he is immediately confronted with the important task of guiding the reparative process through and to the successful issue that will not only protect the patient against serious complications, but which will also leave the once injured body in the best possible condition: sound, healthy, and unblemished. The word "guiding" is used advisedly, because the first rule to lay down in the management of wounds is that wound healing is a process of nature that can be guided—influenced, but not forced. The surgeon does not heal a wound; he merely puts it and keeps it in a favorable condition to heal. The inherent, mysterious, subtle, cellular activity that begins as soon as a wound is inflicted and ends in strict obedience to an inexplicable law as soon as the breach is filled up with just enough new tissue to level off the excavation, is indeed a process to be guided rather than forced by any outer interference.

The student of wound healing who first of all learns the wisdom of non-interference with this process has already laid down a good foundation for wound treatment. In other words, he who bases his management of wounds upon the fact that the new tissue that sprouts out from the walls of a traumatic cavity under normal conditions grows safely to a useful, mature tissue without outside help, is the successful healer,

while on the other hand he who is bent upon constant meddlesome interference with the germination, growth, and maturing of the reparative elements required to restore the lost elements, invites complications, retards the normal activity of tissue construction, and usually leaves indelible blemishes as evidence of his harmful practices.

The system of wound treatment in general use in the veterinary profession, to be perfectly frank, does not entitle us to much credit. Our therapy in this connection is severely lacking in the refinement that enables the surgeon of human beings to make and manage successfully enormously large wounds. The reader may here insist that he has obtained good results from his wound treatment. But is this really the fact? Is it not more nearly the truth that our successfully treated wounds are, after all, trivial wounds, and that our really serious wounds, surgical or accidental, are too often fatal, or that they permanently disfigure or permanently disable our animal patients? And is it not still a painful fact that the whole veterinary profession continues to exhibit a real fear of extensive surgical wounds because of their bad behavior? And is it not still the truth that many of us fear to invade the splanchnic cavities and synovials, believing that accidental wounds of these cavities are fatal and surgical wounds very hazardous? Such an impression should no longer prevail among us, at least not to the same extent as in years gone by. With our knowledge of regeneration on the one hand, and of the pathology of wound complications on the other, we should approach almost any wound with more confidence than formerly; and then by planning various schemes to remove every harmful element, inherent and ulterior, a very remarkable success may be achieved in the treatment of even

very serious wounds. It must be borne in mind first of all that the wounds we meet and make, and the nature of our animal patients, call for special systems of management from the beginning to the end of the healing period. After we have followed the general principles which should govern the management of wounds of all living creatures, there are still special plans, systems, methods, and procedures applicable to our patients which must be executed in order to meet the requirements needed to obtain the best results.

The necessity for skillful, scientific, ingenious wound treatment is estimated best by those who venture into the field of major surgery. Just so long as the surgeon restricts his enterprises to minor procedures, the refinement of technic required to succeed in major work is not appreciated, as the minor wound heals in spite of the method, while the major wound ends fatally or in some other disaster. In short, if we desire to go onward with our animal surgery we must first surmount the various obstacles due to the fact that our patients belonging to the brute creation are unable to give the surgeon any help, are barely worth the expense of much surgical work, and are always dirty and are always kept in dirty surroundings. To do good surgical work even with these obstacles working against us, is our task, and it is a task we must in some way master. We are no longer compelled to sing the praises of aseptic work; everybody now recognizes its merit, no one but the very ignorant ignores it; and as I once heard a medical bystander remark: "Even the horse doctor practices it." Ten years ago we were frantically defending asepsis for animal surgery as a more or less practical procedure; to-day everybody knows it can be successfully practiced through almost every surgical operation and through the postoperative convalescence.

Wound infections of the surgeon's making, once the rule, are fast becoming the exception.

During the last two decades the veterinarian has, of course, learned much, with the rest of mankind, about the nature and behavior of wound infections, and especially about the manner wound infections are carried into wounds. We have been painfully slow to acknowledge the venomous nature of our hands and instruments, in our well-rooted belief that microbes around a surgical operation on animals were so abundant and so volatile that no system of procedure could cope with them. With all of these prejudices out of the way, and with every one satisfied that the animal surgeon may now, if he chooses, protect his patients against these self-made infections, our attention must be directed also toward other obstacles. What these are and how we may attempt to meet them will be considered in the succeeding paragraphs. The object of this article is more to bring the modern conception of wound treatment before the profession in the hope that a better system of wound treatment applicable to animals may be adopted in the veterinary profession to the decided benefit of our onward march toward higher levels; precisely as a few years ago it was found necessary to preach the gospel of asepsis. That these obstacles are formidable, and the recommendations I may be able to make inadequate, is hereby acknowledged.

The treatment of wounds! Let us understand one another. What to rub on a wound or what not to rub on a wound is not in our mind in this discussion. On the contrary, we are taking the treatment of wounds in its fullest sense, "The curing of the patient by the surgeon," for this is what wound treatment is, after all. In surgery the healing of the wound is usually analogous to curing the patient. It is evident, therefore,

that wound treatment begins in the preoperative deliberations over a proposed surgical subject, for if the wound will not heal, no operation is indicated.

Preoperative Treatment of Wounds

Under this somewhat irrelevant title is included a consideration of those systematic conditions which mitigate against the healing of wounds made by the surgeon and those accidentally inflicted; the influence the general health will have upon the behavior of a proposed surgical wound; the condition under which the patient must live during healing; and the amount of intelligent after-care it will be possible to administer.

The bearing of the health and especially the vigor of a wounded patient upon the healing of a wound has too often been ignored. In a large city, where horses are often reduced to a pronounced state of general enfeeblement from hard work, or from hard work and privation combined, the influence of this element in the behavior of wounds is most appreciated. The serious nail prick, implicating the pedal synovials, for example, will respond to active treatment in the vigorous subject, but will prove fatal in the weak. In the strong, wounds are inclined to have only a local effect, while in the weak, bacteria and their metabolic products are almost certain to tend to generalize and cause such grave complications as septicemia, pyemia, and embolic pneumonia.

The management of wounds must, therefore, begin in the preoperative deliberations. We must know first if the patient is fit to withstand a given ordeal, and then plan accordingly. I know of no one element that works so much harm in animal surgery as that of operating upon the weak subject. Whether the enfeeblement is due to disease or other influences does not matter, the

relations between the patient's condition and the traumatism is of equal importance.

The point may be illustrated in fistula of the withers. In a young, vigorous subject with a fistula of recent origin, before or soon after the first abscess has discharged its contents the surgeon may proceed fearlessly to the most radical steps, with a full assurance of a rapid recovery. The trauma may be large enough to cause considerable shock, and the blood loss may be great, but in spite of these there is prompt reaction from the shock and a prompt healing is soon progressing. On the other hand, a subject affected with a sapping fistula that has been draining the system for months may be too feeble from anemia and chronic septicemia to withstand even a minor operation. The one will recover, the other may die.

Scrawny, ill-wintered colts fall victims of castration, while the vigorous seldom die. I know of no greater hazard than herniotomy or cryptorchidectomy in enfeebled subjects. In the case of accidentally inflicted wounds, precisely as in surgical wounds, there is this same element of vigor working for or against the surgeon, and unless due attention is given thereto, wound healing may take a bad turn right from the beginning, even if the patient recovers from the shock inflicted. Case after case might be related to illustrate this point. It should, however, be sufficient to say that the vigor of our animal patients has such a marked effect upon the results of our surgery that no surgical operation should ever be thought of without first giving due consideration to the influence the general health will have upon the final results.

The remedy in other than urgent cases is to improve the patient's condition by every available and practicable means. I have often postponed poll-evil and fistulæ

operations for ten days to two weeks pending an improvement of the patient. The abscesses were lanced and irrigated and the patient, previously working perhaps, was rested, groomed, fed well, and medicated until a better state of health was induced. The loss in time in such cases turns to actual gain in the more speedy recovery—that is, in the more rapid healing of the wound. The hairy, pot-bellied colt, that has subsisted on roughage all winter, should get the invigorating effect of two weeks at pasture before it is castrated, and like precautions should be taken throughout the whole category of surgical operations.

In emergency cases the weak require, as a remedy against their enfeebled state, a much more painstaking method of procedure to prevent infection, more careful anesthesia, and a more constant and diligent after-care. It is here that vaccines find their greatest usefulness in animal surgery. Although general systemic enfeeblement does not always indicate a low opsonic index, our observations lead to the conclusion that vaccines wield a powerful influence for good in the great majority of cases of this type.

The administration of iron, quinin, and potassium iodid to encourage a better behavior of wounds has many defenders, and no doubt serves as a more or less valuable adjunct to the feeding, bedding, grooming, and general care of weak surgical subjects.

Another point in the preoperative attention of patients is the care of the feet. Any horse about to be subjected to a surgical operation, whether the wound is intentional or accidental, should be given the benefit of good "underpinning." The shoes should be removed and the feet pared and then reshod, so as to give the most comfort. This is particularly important when the standing position must be maintained day after day.

In operations upon the feet for disabling lamenesses, there is nothing so important as the opposite leg and foot, which must now bear the burden of two. While the patient is still on the table, the shoeing of the opposite foot should be scrutinized, and corrected if necessary. The sound leg, becoming tired, the weak patient will often lie down and refuse to rise to bear the weight on the aching member. Such cases soon become bedridden, and seldom recover.

In fine, it might be truthfully said that no surgeon of animals will have success with serious operations if he wades into them with a reckless disregard for the resistant powers of his patients. The surgeon of human beings studies his patient for days. He puts him to bed, diets him, purges him, stimulates him, examines his urine, his blood pressure, his heart, and then finally decides to operate. But we veterinarians often wade into our patients without a forethought, and then wonder at the mortality.

The operations in which there is an especial need of weighing carefully the vigor of the patient in order to forestall disaster are more numerous than might at first be supposed. The more common are:

1. Radical operation against poll-evil.
2. Radical operation against fistula of the withers.
3. Ablation of scirrhous cords, botryomycomata, shoe boils; goiters, nasal tumors, eyeballs, and so on.
4. Radical operations for large hernia-ventraloceles, oscheoceles, and exomphaloceles.
5. Cryptorchidectomy.
6. Operations upon infected tendon sheaths and articulations.
7. Surgical treatment of large lacerations of the buttocks and shoulders.
8. Surgical treatment of abdominal wounds with visceral injury.
9. Amputations following serious accidents.

A review of these procedures, and there are many others, shows clearly that major operations of a serious

character—serious on account of the magnitude of the traumatism—are indeed numerous. They include the surgical operations of animals that are actually worth the trouble and expense entailed in their performance and after-care, because the salvage is always considerable and in most cases amounts to the full value of the individual afflicted. The existence of animal surgery therefore depends largely upon our ability to work out plans of wound treatment that will carry such patients safely and promptly through the period intervening between the completion of the operation and the final cicatrization of the wound. In short, to make animal surgery actually worth while we must make, and then manage, large wounds better than we have done heretofore.

Previously in this article we endeavored to show that the initial fault in wound treatment is the lack of effort we make in the preoperative examination of our surgical subjects. To wade recklessly into a patient before weighing carefully its ability to bear the effect of the traumatism we are about to inflict seems to be a sin we continue to commit. In view of the other obstacles under which wound healing in animals must proceed it is plainly important to start out with the best physical condition it is possible to produce. Every means at our command should be drawn upon to accomplish this end.

I shall repeat that our best surgical subjects are those well cared for, well fed, and worked enough to keep them muscular, and the poorest risks are those badly fed, worked hard, and housed in poorly ventilated stables. To the latter may be added animals sick and enfeebled from the disease for which they are to be operated upon. The former stand surgery well, while the latter are victims of complications; the former need

only a preparatory dieting to avert operative accidents, while the latter are seldom fit for major surgery until the lost vitality has been restored. A physical examination for pulmonary, cardiac, digestive, and locomotory disorders is particularly demanded. Urine analysis, blood counting, and bacteriological tests of discharges and secretions are less called for in animal surgery than in surgery of human beings, and in fact are only seldom of sufficient importance to warrant one in resorting to them, but the knowing animal specialist comes to conclusions about the physical condition of his patients by their general appearance and the lives they have previously led.

The Cost of Better Wound Treatment

The question of cost always enters into any detailed dissertation on surgical operations. It is usually thought imprudent to add still more to the already high overhead expense of our surgical work. To eliminate the necessity of referring to this feature again, we shall state flatly that the actual value of our surgical operations is not reflected in the prices in vogue to-day. The veterinarian should make them more valuable by doing better work. This is the pure and simple solution of the ridiculously low prices we receive for our surgical services. A scale of prices should be an elastic scale. We must do what the surgeons of human beings do: operate upon the poor for nothing, and claim a reasonable fee where the cost is less an object. In veterinary surgery we should operate upon cheap animals for less than upon those where the salvage is great. Five, ten, fifteen, or twenty dollars may be ill spent for an operation that ends unsuccessfully or in a long convalescence; while twice these amounts for operations that promptly

restore useless animals to their full value would be regarded as good investments.

Operations upon cheap animals, performed with a thoroughness that makes for good results, will always amply pay the surgeon in experience if not in money; and this experience can always be turned to good use when conditions are more favorable for the collection of a good fee. Any attempt to arrange prices on any other basis is destined to failure. It is becoming more and more evident that better surgery offers us the best opportunity to increase our incomes.

A Few Words on Asepsis

The precautions for preventing the contamination of wounds while making them, or while treating those accidentally inflicted, have revolutionized the surgical art. To-day the surgeon must work religiously throughout an operation to prevent the soiling of tissues with infection, and this has greatly complicated surgical technic. The mere cutting process is often much simpler than that of preventing the open tissue from becoming contaminated with pathogenic bacteria. Surgery includes to-day not only the classical incisions, resections, and dissections, but also a complicated prearranged plan for performing these operations without depositing harmful bacteria into the trauma. The fact that bacteria are harbored upon and within all objects directly and indirectly connected with the procedure, calls for preventive measures that are by no means easy to carry out. The prevention of operative infection requires knowledge of bacteriology and pathology that is not possessed by the charlatan, and it is here that the educated practitioner can find the greatest weapon to use against his charlatan competitor.

There are a certain definite number of objects that touch wounds, and aseptic surgery might be correctly defined as the art of preventing these from inoculating bacteria into them.

The air, the instruments, the surgeon's hands, the assistant's hands, the surgeon's clothing, the assistant's clothing, the operating place, the sponges, the solutions, the containers of solutions, the sutures, the dressings and bandages, the surroundings of the wound (surgical field), and the patient's habitat include all of the objects capable of conveying infection. Aseptic surgery dictates a rigid handling of all of these objects. None must be ignored; each must be made absolutely harmless, or at least as nearly harmless as is possible and practicable. To make a sane effort to prevent wound contamination from each of these conveyors in every operation is a modernism that should no longer be neglected in veterinary practice. The methodical handling of these to this end, in a surgical operation, is an exhibition of knowledge and of skill—a spectacle deserving of praise and sure to win applause from intelligent judges, and a means of accomplishing the best results. The veterinarian should realize there is also a legal side to this question: that he may be made accountable for infections of his own making, when precautionary measures have been disregarded.

Air as a Conveyor of Infection

Except where patients can be taken out into the open, on a clean grass plot away from the dust of trodden corrals, roads, or tilled fields, the air is capable of conveying dangerous infections. The air itself acts only as a carrier of particles which in turn carry bacteria. When there are no particles suspended in the air it is harm-

less; when it is laden with suspended or flying particles it must be reckoned with, and is probably more often the source of mysterious wound infections than we at first supposed.

In my earlier teachings I was inclined to make light of the possibilities of wound infections from this source, just as the surgeons of human beings were doing after they demonstrated the fallacies of Lister's historical "phenicated cloud." But a wider experience has taught me that the air of stables, and especially of veterinary hospitals, is quite different in this regard from that of hospitals for human beings.

While it is no doubt a fact that most of our infections come from other sources, the air of our operating rooms is not to be entirely ignored. Such rooms are usually dust laden, the dust originating from badly contaminated floors, and even when measures are taken to allay dust, the room may become recontaminated around the surgical field with dust raised from the patient's body. The body of a struggling animal may thus become a veritable pest. Dust and hairs loosened by struggles and then whirled about by drafts often create very dangerous conditions and are difficult to manage. We would be making a poor start toward perfection in aseptic practice were we to continue to disregard these dangers.

Refined nosocomial work demands special care to allay suspended room dust by spraying, and to prevent the raising of dust by mopping and flooding floors instead of sweeping, and by wiping furniture and utensils instead of dusting them. When these precautions have been taken the patient itself might be brought in, well groomed and moistened with a damp cloth to reduce to the minimum the amount of dust raised from the body. This latter recommendation is particularly

important around the surgical field. These environs may even be well soaked with water.

For the outdoor operation the trodden corral and tilled field are particularly dangerous, for the dust from these sources is ridden with bacteria of the most harmful sort, and usually there is wind to whirl about the particles raised by the patient's struggles.

Youngsters, either equines or bovines, shedding the long shaggy winter coat, are about the most miserable surgical prospects imaginable. In operations upon such animals great clouds or even bunches of hairs are sometimes swept into wounds, and if there is added to this the dust from a bare paddock the condition is abominable and strictly unfit for any kind of surgical work.

The use of any kind of litter as an operating bed may likewise be condemned. There is no fit litter for surgical work. A ban might as well be put on all kinds of loose beddings used to make a soft place for restrained animals to lie upon during operations, for it is positively impossible to maintain a decent state of surgical cleanliness with loose particles whirled or trailed into or near the wound at every movement. Whenever the weather is too inclement for outdoor work it is better to cast animals upon a bare floor, protecting the head and hips with blankets if thought necessary. The actual difference between a bare floor and a floor bedded with two or three inches of straw is not great, measured from the standpoint of the patient's comfort. Beddings are usually pushed aside and the body rests upon the floor before the operation is far advanced, and about the only good accomplished by the bedding is the psychological effect it has upon the audience. Shavings properly moistened can be controlled better than any other bedding, but these are seldom available and are none too safe. It is better to abandon entirely the use of

litter as a surgical appurtenance, and thus dispose of one of the sources of air contamination.

In short, air is a prolific source of wound infection in animal surgery that should be dealt with consistently. It is not so dangerous as Lister taught before the days of bacteriology, but more dangerous for veterinarians than for the surgeons of human beings, who operate under much more favorable conditions than is ever possible for us.

Instruments as Conveyors of Infection

As instruments come into direct contact with wounds they are more certain to inoculate them than the other objects used in wound treatment. The metallic instruments used in surgical work (knives, forceps, and so on) become progressively more dangerous day after day unless submitted to an effectual sterilization. That is, instruments used from the pocket case or from shelves of the instrument case soon become very dangerous. They will infect every raw spot they touch with appalling certainty.

Wound infection from this source is avoidable under all circumstances in veterinary as in human surgery, and should therefore be entirely eliminated. There is absolutely no excuse for wound infection from instruments. They can and should be sterilized before every operation and then so handled during an operation as to prevent them from becoming contaminated. Veterinarians who continue to operate without first sterilizing their instruments are fortunately fewer than formerly, but I regret to say they are still legion.

Boiling is by far the easiest as well as the safest method of making instruments safe. To assure safety, metallic instruments should be boiled ten to fifteen min-

utes. Cutting instruments are harmed somewhat by repeated prolonged heating; our present plan is to pick up the knives from the boiling water after two or three minutes and complete the sterilization by placing them in a jar containing denatured alcohol. Alcohol sterilization alone for scalpels and bistouries is depended upon by many, and if the immersion is long it may be regarded an appropriate and safe expedient for the particular purpose of assuring the best sterilization possible without injuring the keen edges of sharp knives.

Rubber goods (gloves, catheters, drainage tubes, syringes) may be subjected to a certain amount of boiling without injury, and as these are not as a rule very costly, such injury as they do sustain is unimportant. Costly instruments of this class can also be made safe by immersing them for some time in strong solutions of mercuric chlorid.

The resoiling of instruments during operations must be prevented by taking care that they do not come in contact with soiled objects. If they become infected by contact with pus or other infected substances they should be set aside and not placed upon or near clean instruments on the tray. The use of a little caution and plenty of common sense is needed in handling instruments, for otherwise the whole plan of clean operating will be futile.

The Surgeon's and the Assistant's Hands

The hands as carriers of infection into wounds we treat deserve more than ordinary consideration, because the hands of surgeons practicing among animals are always liable to infect wounds. In short, the hands belong to the first rank as infection carriers, not only of ordinary pyogenic infection but also of infections of

more serious import. Working continually among infected objects and infected structures of the body of diseased animals that must be handled manually, the veterinarian who indulges in major surgical work, or who desires to have nice results from his minor work, must learn first of all that his hands are dangerous and unless managed properly will defeat his every other precaution to perform aseptic operations. The hands that remove a putrefied placenta or decomposed fetus are not fit to handle internal organs or raw wound surface for some time, even when careful washing precedes the operation, for no washing, no matter how carefully done, will immediately rid them of infectious material.

The exact truth in this connection is that bare hands are never safe. Even the hands of the human surgeon are not so regarded, and his work is by no means of such a filthy character as that of the veterinarian. Just before operating, the veterinarian is often engaged in much dirty preparatory work—casting or otherwise securing his patient. The paraphernalia used around a veterinary surgical operation is dirty in the surgical sense and abominably contaminated with the dirt of preceding operations. As these must be handled with the hands, there is little chance of the veterinarian ever having hands that are fit to handle tissues or instruments that must come in contact with tissues. And since the wearing of sterilized, skin-tight rubber gloves is not practicable for ordinary operations, it would seem that we here meet an insurmountable obstacle.

The truth is, however, quite different, for if we practice the art of *avoiding the digital manipulation* of raw surfaces the obstacle is at once removed, no matter how dirty the hands are. Ablutions of soap and water followed by a rinsing in mercuric chlorid are all that is needed to prevent infection from the hands when han-

dling the tissues with the fingers can be avoided. While such hands still harbor and deposit infections, they touch only the handles of instruments; the blade of the scalpel and the jaw of the forceps are not soiled, and thus do not convey hand contaminations. By exercising a little care to prevent the handles of instruments thus soiled from touching the parts of other instruments on the tray that will be subsequently used on the raw tissues, the infection of wounds with the hands becomes negligible in veterinary surgical operations in spite of the fact that they are all the while badly contaminated with bacteria. In addition, however, we must not forget the assistant's hands. These come into even closer contact with the wound while baling blood than those of the surgeon himself. In handling sponges the assistant must endeavor throughout to keep the part of the sponge he touches with the fingers from touching the wound—a plan easy of execution—and under no circumstances should he bring his fingers directly into contact with the wound. When he hands instruments to the surgeon he should touch only the handles or convey them with forceps. The rules we have put into operation to prevent wound infections from the hands are as follows:

1. Avoid all unnecessary handling of raw tissues with the fingers.
2. Rinse the hands with mercuric chlorid (1 to 500) after washing them with soap and water. During the operation rinse them frequently in a deep basin provided for the purpose.
3. Wear gloves while scouring the patient.
4. Touch only the handles of instruments that contact raw surfaces, and so arrange them on the tray that the handles will not come into contact with the blades of knives or jaws of forceps that will subsequently be used on the raw surfaces.
5. Handle needles and sutures with the forceps only, or wear sterilized skin-tight gloves while suturing.
6. Soak sutures previously sterilized in tincture of iodin so that soiling will be less harmful.
7. Where digital manipulations are needed, as in spaying or ridgling castration, the hands cannot be made entirely safe. Washing with water, rinsing in mercuric chlorid solution,

rubbing them with alcohol, and then painting the fingers in weakened tincture of iodin combines the best resources we have. The latter—the iodin—is objectionable, because of the staining and because it blunts the tactile sense, so much depended upon when digital work is actually necessary.

Wearing clean gloves while doing the preparatory work, the washing and rinsing of the hands as above proposed, avoiding unnecessary manipulations with the fingers, and wearing sterilized, skin-tight gloves while suturing are just so many *practical* means of averting wound infection from the hands, and when these simple means are resorted to hand infections are comparatively rare. There remain the unavoidable infections when the bare hands must be used.

Sponges

Absorbent cotton is the best sponging material for general use in veterinary practice, especially where a large number of sponges will be needed during a given operation. Gauze comes second, and while decidedly the safer, absorbent cotton is delivered in clean packages and is easily sterilized whenever absolute purity is demanded. Our plan of handling cotton for important operations is to place a sufficient amount in the sterilizer with the instruments and when well boiled cool it off in a basin of mercuric chlorid solution (1 to 1,000) made with sterile water. This is then the assistant's basin. During the operation he takes his sponges from this basin as fast as they are needed and of course casts them aside when soiled. This plan tends to keep the assistant's hands safer by their repeated contact with the antiseptic solution containing the cotton.

Where there are plenty of especially assigned assistants to look after the surgical paraphernalia, as in college clinics, sterile gauze sponges used in the same

way are preferable. These may be resterilized for future use.

Sponge sponges are very effectual in absorbing blood from wounds, and on this account are defended as best by some veterinarians. By keeping them in a strong antiseptic solution they can of course be sterilized, but unless these are used like the gauze and cotton sponges, being cast aside when soiled, their use cannot be recommended under any circumstance. It is best to dispense entirely with the sponge and at once eliminate a very common source of wound infection.

Solutions and Their Containers

There is no material about veterinary surgical operations more erroneously used than the antiseptic solution. I find that veterinarians are still placing too much dependence upon the microbicidal value of chemical substances dissolved for surgical use. Unless the water, the basin, and even the drug are sterilized, no antiseptic solution is safe. In fact, antiseptic solutions are one of the commonest sources of wound contamination. They soil more than they are capable of disinfecting. They carry bacteria into wounds where none previously existed, and they are ineffective against bacteria lodged in the tissues. The statement that *pathogenic bacteria are more viable than the cells of the body* cannot be too often repeated. The explanation of the stubbornness of wound infections against antiseptics is found therein. The simple truth is that antiseptics injure, devitalize, and even kill cells to the advantage rather than to the disadvantage of bacteria growth.

From these facts it is evident that the antiseptic solutions we use should be more intelligently prepared and handled than is customary in veterinary surgical opera-

tions. Water from the well or hydrant brought in the milk pail or stable bucket, no matter how clean looking it may be, is a sure carrier of infection. To add to this water an antiseptic drug does not improve matters as much as is generally supposed; the solution is still an infection carrier of the most certain sort. Experimental studies of the viability of various microbes in the different solutions used in surgical operations tell plainly enough why wound infection from this source is so common. Sterilized water held in a sterilized basin without any antiseptic drug is much safer than medicated water that is laden with bacteria, as almost all waters are.

Analyzing the reason why sterilized water is still so rarely found in veterinary operations, I find that the principal argument against the use of this valuable and very inexpensive product is that water boiled just as the animal is about to be operated upon is always brought to the scene of the operation too hot to be handled, and as it does not cool very fast there is always an inclination, in the haste of getting through with the work, to cool it off with cold water. This of course spoils everything; and knowing this, the country veterinarian soon abandons his effort to stick strictly to this product as a menstruum for his solutions.

It is, however, worth while insisting that every drop of water to be used in any important operation should be boiled for fifteen minutes and brought out in the original vessel. The time allowed for it to cool is time well spent. In my rural operations I frequently fill the large wash boiler with water, place in it the basins, dipper, bandages, and sponges to be used, and then boil all together for fifteen minutes. In the meantime the instruments are being boiled in the regular instrument sterilizer—an apparatus that every veterinarian should carry with him everywhere. It requires about fifteen

to twenty minutes for these to cool off, and this time can be utilized in preparing the patient.

This is a general plan that every country practitioner should follow sacredly. The unfortunate sequences of many of my country operations during past years I attribute to this source of infection. *Suppuration galore, surgical septicemia, malignant edema, tetanus, peritonitis, and other consequences following operations that one has taken especial pains to do well may often be traced to bad judgment in providing the solutions.*

The best plan the country veterinarian can lay down as a start for better surgery is the use of the housewife's wash boiler in the manner mentioned above.

In hospital operations sterilized water is more easy to procure. It can be stored in large bottles ready for use, and the instrument sterilizer should be large enough to sterilize the basins into which the water is poured. Too much dependence must not be placed in the hot water from the hot-water tank even though it comes out steaming hot. Tank water whose temperature is maintained around 200 degrees Fahrenheit for hours is, however, safe enough for ordinary surgical work.

Sutures

The certainty of wound infection from unsterilized sutures is due largely to the fact that they sojourn so long in the injured tissues. The bacteria they carry always find a favorable environment for growth in the enfeebled tissues they hold together, and even when sterilized and placed with exceptional care, stitch suppuration may develop from skin bacteria that cannot be dislodged in the preparation of the surgical field.

On these accounts sutures in veterinary operations call for special methods of handling. They must first

be boiled for at least fifteen minutes, bathed in pure tincture of iodin, and then so handled as to prevent contamination through trailing over unclean places or from the soiled hands.

We defend the use of antiseptic sutures instead of aseptic sutures chiefly on the grounds of expediency. Such sutures can be handled more carelessly with the bare hands, they are less apt to get soiled from accidentally trailing over soiled places on the patient, and stitch suppuration from skin bacteria is made negligible. The nature of our operations demands this expedient. This applies, of course, only to removable sutures, that is, sutures for the skin. Buried sutures for the underlying integuments need not be so treated, but should always be purchased sterilized and in sealed containers. The veterinarian has no way of safely sterilizing raw gut, and therefore should not undertake to do so.

In suturing wounds the needle is held in the needle-holder, and the end of the thread that is handled may be cut off when the needle is threaded. The assistant may then keep the dangling end from trailing over the patient by holding it up with forceps as it is drawn through; or the surgeon may at this stage of the operation put on a pair of sterilized, skin-tight rubber gloves and handle the needle and thread with the fingers, keeping the thread in the palm of the hand to prevent trailing. Either of these plans will answer.

There is no use in practicing other aseptic precautions if any carelessness whatever in handling sutures is allowed to creep in, because here we have a certain infection carrier. A wound may sometimes escape infection from contaminated air, instruments, or hands, but never from sutures that are not absolutely aseptic and carefully handled.

Wound Packing, Drainage Wicks, and Draining Tubes

Inasmuch as we continue to use compression packs to control copious bleeding after some of our operations, these are capable of acting as carriers of bad infections. A soiled wound-pack sewed up tightly in a traumatic cavity is a mighty dangerous object. In twenty-four hours it is fetid, and in forty-eight hours, if not removed or the sutures loosened to admit air, malignant edema is very likely to have developed. The large cavities of ridgling castration, of fistulæ of the withers, of poll evils, and of large tumors are to be feared in this connection. Recently a case of this kind came to my notice. A ridgling castrated after some difficulty was packed with cotton that was simply disinfected in mercuric chlorid solution made from well water and contained in a milk pail. The wadding was held in place by snapping the edges of the wound with a clamp forceps. When removed forty-eight hours later the wadding was fetid, the scrotum was swollen, and the patient stiff and sick. There was a perceptible emphysema in the loose areolar tissue along the inguinal canal. Two days later the patient was swollen with an emphysematous edema along the ventral surface of the body as far forward as the elbows. Death occurred a few hours later. I have had similar results from operations upon fistula of the withers where soiled packings were injudiciously allowed to remain sewed up too long. These infections are wound-packing infections, and must be reckoned with in wound treatment.

The best wound packing is sterilized oakum, sterilized by boiling and not alone with antiseptics. Oakum is better than cotton for this purpose because the latter stubbornly mats into raw tissues and stays there for two or three days. An oakum pack comes out *en masse*, leaving no particles behind.

For wicks to act as drainage in counter openings, or in the lower commissure of wounds, sterilized antiseptic gauze is most suited. Drainage tubes should be boiled before being fixed into a wound.

Protective Dressings as Conveyors of Infection

Bandages, absorbent cotton, oakum, collodium, dusting powders, and wound varnishes are the objects used as protective dressings. The truth about wound treatment in this connection is that a wound closed without having been infected in the process of treatment is not apt to become infected later. Postoperative infection I know is often a very convenient cloak to cover up operative infection. The castrator, in all the seriousness of a minister, chastises the owner of a dying colt for having allowed it to inhabit a dirty stall when in fact the infection responsible for the stricken animal's condition was deposited with his own hands or his own unsterilized or half-sterilized emasculator, at the time of the operation, and this example explains the mystery of nearly all our wound infections.

Collodium, dusting powders, and wound varnishes seldom convey infections because they are clean, antiseptic, and drying. Bandages and cotton, however, placed over a wound, require attention as infection carriers. I am a believer in antiseptic wraps for wounds, and depend upon aseptic wraps only when renewal is frequent. An aseptic bandage that becomes soaked with wound serosity, or that holds wound discharges against the skin around a wound, is not so good as one that contains iodoform, mercury, or carbolic acid, because the serum in such a bandage does not putrefy as soon as in an aseptic wrap.

It is our practice to dust a powder of iodoform, bismuth subiodid, or boric acid over the wound and then cover this with cotton and a bandage soaked and rinsed out of mercuric chlorid solution (1 to 200). With these

simple precautions protective dressings are deprived of all harm.

The Surgical Field as a Conveyor of Infection

A good liberal zone around a wound or proposed seat of a wound must be submitted to the classical cleansing process, now regarded as standard for this purpose. It consists in washing with water and soap, clipping, shaving, rinsing, and rubbing briskly with mercuric chlorid (1 to 500), and then painting with tincture of iodin. This does not positively sterilize the skin of a hairy animal, but it combines the best means of producing the safest possible field for a cutting operation.

The surgical field conveys infection during the operation by being directly at the wound, and after the operation by the growth of bacteria on the serum-soaked skin. It is therefore evident that any laxity or omission here is serious.

Postoperative Conveyors of Infection

As mentioned in the foregoing paragraphs, postoperative infection is not so common as is generally supposed or, better still, not so common as the surgeon would have his clients believe. That there are postoperative infections is of course admitted, but the search for causes will usually be more successful if the operative methods are scrutinized.

It is, however, plain that the same careful handling of everything that prevailed during the operation must be continued during the after-care, especially during the first four days. It is a misfortune to be compelled to turn over the after-care of wounds to untrained hands, but if we plan our after-care with this in view we can

generally succeed in keeping our really aseptic wounds from harm.

The postoperative conveyors are the patient's bed and stall and the attendant's hands, syringes, solutions, powders, and dressings.

The patient's habitat is made safe by keeping the wound covered, keeping the patient in the standing position, and keeping up a sensible state of cleanliness in the surroundings.

The handling of wounds by attendants should be avoided. They might be entrusted with the dusting of powder on a sutured wound, applying a clean piece of gauze or cotton and wrapping a bandage over all, but this is as far as any untrained hands should be trusted in the treatment of aseptic wounds. A wound requiring irrigation and renewal of drainage wicks or tubes requires also the intelligent assistant or surgeon, as these means are sure to infect.

Syringes and solutions in wound treatment should be given into the hands of others only in the treatment of suppurating cavities where refinement is unnecessary.

I would summarize the plans of handling the various conveyors of infection as follows:

1. Operate in an atmosphere that is free from dust, and prevent objects from being whirled about by the patient. Avoid loose bedding, and moisten the patient to keep the hair from flying.
2. Boil instruments for fifteen minutes and so handle them during the operation as to prevent contamination. Call for other instruments to replace those soiled.
3. Avoid touching the wound with the fingers. Use tissue forceps, tumor forceps, and needle holders. It is seldom necessary to touch wounds with the fingers. When digital work is necessary, wash the hands, rinse them in mercuric chlorid (1 to 500), and coat the finger tips with tincture of iodin.
4. Use only sterilized water and sterilized basins.
5. Prepare a large surgical field in the manner above recommended.
6. Use sterilized sutures and bathe them in tincture of iodin. Keep them from trailing over the dirty body. Handle them

with the needle holder, or else wear sterilized, skin-tight gloves while suturing.
7. Protect wounds with antiseptic dressings instead of aseptic.
8. Attend yourself to the after-care of wounds instead of trusting it to untrained hands.
9. Prevent wounds from coming into contact with the stall, bedding, or ground.

Classification of Wounds

The time-honored custom of classifying wounds into incised, lacerated, punctured, and so on, although almost consecrated by usage, serves no useful purpose and might therefore be entirely discarded in the study of wound treatment. These names reflect only the character of the causative instrument, and that without giving a hint about the particular treatment they might require. As a basis for a detailed description of wound treatment these names are useless unless prefixed with simple, perpendicular, complex, superficial, oblique, deep, transverse, soiled, mutilated, sheltered, venomous, or some other descriptive adjective that would indicate the plan of management.

Take for example an incised wound, the basis of nearly all surgical operations. That it was made with a sharp instrument is less important in the treatment than the fact that it was made with a dirty knife, that its direction is such that it cannot be drained, or that it is located in a place where muscular movements cannot be controlled. These are a few of the elements that call for special management of animal wounds, and it is upon these that a classification should be based.

The classification that appeals most to the writer is one which at once indicates a particular plan of management, as follows:

1. Aseptic incised wounds; wounds without loss of tissue or in which the loss is not great.
2. Wounds with loss of underlying tissue which can be bridged

over with the skin and whose cavity can be drained by gravitation of the discharges.
3. Wounds that cannot be drained by gravitation of the discharges. Open wounds.
4. Venomous wounds.
5. Punctured wounds.
6. Gun-shot wounds.

Aseptic Incised Wounds

These are always surgical wounds, made in a prepared field with a sterilized knife and touched only with sterilized objects—sponges, hands, solutions, and so on. Incised wounds accidentally inflicted must never be placed in this category, as the sickle, razor, scythe, saber, or dagger capable of inflicting them are not aseptic and therefore soil the tissues in the process of making. Although these instruments may seem clean, they are actually poisonous in many instances, depositing infections that make the wound behave badly, and when closed with sutures with no provisions for drainage they may often end in a threatening if not fatal septicemia.

Treatment.—The handling of this class of wounds is indeed very simple. The first step is to close them up completely with sutures so arranged as to bring and maintain perfect apposition of all of the integuments—skin, fascia, and muscle. Each integument—usually only the skin is involved—is brought into very accurate contact without, however, tightening any part sufficiently to cause stitch necrosis. Sutures that have been boiled fifteen minutes and then bathed in pure tincture of iodin are the only sutures we use for this purpose. As we have previously mentioned, these are recommended because they are seldom soiled in the handling.

The second step is the protection against infection during the succeeding seven or eight days. The best method is a varnish of collodium applied layer after layer as

soon as the wound and environs can be dried of blood and moisture. Collodium serves the double purpose of protecting against soiling and of supporting the sutures. On the limbs where bandaging is feasible, smothering such a wound with iodoform or bismuth subiodid, pure or mixed with boric acid, is a still better plan than the application of a wound varnish. The powder should be held against the wound with cotton. As bandages are apt to bind or become disarranged, the dressing can be renewed every second day without, however, disturbing the sutures or the powder encrusted around them. The redressing amounts to a renewal of the powder that falls off when the cotton is removed. The delicate fibers that will eventually mature into a firm union of the two edges are not to be disturbed by any handling, for if these are once broken there will be no primary union, even if there is no infection.

During these days special efforts are made to provide against mechanical injury due to the patient's lying upon the wound or rubbing it against the stall, or from movements of the limbs and body. This can usually be done in large animals by simply preventing decumbency for eight days. It is impossible to protect a wound against the strong movements of a horse's getting up and lying down, no matter where the wound is located about the limbs and trunk.

The standing position for horses, and strong thick wraps for small animals, is the best we can do to provide against mechanical injury.

Between the seventh and the tenth days the sutures may be removed. Sutures that are doing no good because of having cut through one edge should be removed at once, but otherwise hasty removal is inadivsable. Ten days is often soon enough to remove sutures of the skin over the large muscles (buttocks and shoulders). At

ten days the wound varnish or powder used to protect the wound will be desquamating and can easily be removed to gain a good view of the sutures. These are removed without pulling the outside dried part through the needle tract. Lifted from the surface with the tissue forceps, they are cut with the scissors and then pulled through from the other side.

The aseptic incised wound is now healed. It requires no further attention. What a goal to strive for! What a reward for good work! And what a wonder it is not oftener sought! To find a wound healed when the sutures are removed is a good surgeon's pride. To have them "kick up" is a nightmare—a reflection on his cautiousness, his skill, or even his knowledge.

Wounds with Loss of Underlying Tissues

This type of wounds, that can be bridged over with the skin and whose cavity can be drained by gravitation of the discharges, is one of the very commonest encountered in veterinary practice. It is much more common than the incised wound without loss of substance. This class includes the wound of many surgical operations as well as almost all of the accidental traumata sustained about the legs, trunk, neck, and head. Whenever a tumor or other object is excavated from the body the surgeon always plans to bridge the excavation over with the skin, or in the case of an accidental wound it is always desirable to bring the skin and other integuments into apposition over the underlying cavity. The aim here is to reduce corporal blemishing to the minimum by prompt surface healing, and to avoid the dangers of anaerobic infections by keeping (in surgical wounds) or making (in accidental wounds) the tissues thus covered over perfectly aseptic.

This wound distinguishes itself therapeutically from the incised wound because provision must be made for the escape of the serum that will exude from its walls, which would fill up the cavity to the physical detriment of the healing process and the decided advantage of invading microbes. Even though a wound is aseptic it must never be allowed to harbor its secretions in any considerable quantity. Wounds of animals filled with serum become putrid despite everything.

Treatment.—If such a wound is surgical, every effort is made to prevent soiling of the tissues during the operation. If any are soiled by contact with dirt or flowing pus, these are trimmed off with the scissors or scalpel rather than depending upon any form of chemical ablution, the aim being to have at the end of an operation a traumatic cavity that is absolutely free from micro-organisms. The surroundings having been previously shaved and disinfected, the wound is now ready to cover over by suturing. An opening at the end of the cavity, or a counter opening especially made, is provided for the escape of the serosity that will exude more or less copiously during the succeeding week. If the orifice thus provided is simply kept open so that every dram of the discharge will flow out, there is no other treatment required except that of maintaining a suitable protection of the sutured portion against external contamination and injury. If infection of the cavity is prevented during the first five days there will be less chance for any successful invasion of microbes thereafter. That is, the first few days, while the tissues are still weakened from the injury they have sustained and before a protective reaction has developed, is the time during which special care must be taken to prevent them from being inoculated with the gauze, the syringe, the fingers, or any object that may be needed to keep the orifice working

as a drain. At the end of ten days the sutures may be removed, but as the traumatic cavity will require another week, or even a fortnight, to cicatrize, the drainage must be continued. In wounds whose cavities have considerable size three weeks should be sufficient time to heal them. Infected wounds of the same size require six weeks to two months or even longer for healing.

The accidental wounds of this class interest the practitioner most. They include almost every bodily injury that animals sustain accidentally by contact with objects capable of lacerating the skin and underlying muscles. Kicks on the buttocks, the thigh, the shoulder, the breast; wire cuts in the heels, the forearm, the hock; and almost all manner of traumatism from collisions, nearly all belong to this class.

The veterinarian here is confronted with the problem of healing up an ugly wound often of considerable dimensions, not infrequently invading the muscles deeply—that is, bruised, torn, and soiled. The desiderata are to heal the wound quickly and to leave behind as little blemish as possible. The ugly scars that mar the bodies of so many splendid horses attest the poor initial treatment such wounds have received.

I am bearing fully in mind the obstacles that confront the country practitioner arriving on the scene of such an accident. The patient is often intractable, the surroundings are not inviting, help is scarce, and last but not least the character of the work required to give the wound a strictly refined treatment is not comprehended by those in charge. "I guess you had better sew it up, doc," is the usual idea of the treatment required. There is seldom any conception of what this suggestion entails if followed out in strict accordance with the rules of modern surgical procedure.

With this prevailing notion of things the rent is

usually patched up with needle and thread after a perfunctory ablution with an antiseptic solution. Four days later it is an open wound again, more seriously and more deeply infected than if it had been left entirely to the mercies of nature. To change this order of affairs is now our serious duty, and in view of the fact that it is exceedingly easy to show the difference between good wound treatment and poor wound treatment the objection to putting a stiff initial cost on the treatment of such a wound will not be long lived. We have done it in a city practice and I am sure the country practitioner can do likewise.

Formerly we treated accidental wounds of all kinds, except enormous ones, in the stables. We secured the patient with the twitch and sideline, washed the wound, sewed it up after more or less of a running fight with the patient, and then applied whatever protection best suited. In the usual four or five days we were always called again to do the work over. "The stitches have broken out," was the usual cry. Sometimes a second attempt at closure was made, but more often the dangling skin was trimmed and open-wound treatment applied during the remaining long process of cicatrization. In such cases there was the cost of the first treatment; of a number of periodical visits during the succeeding six weeks; of antiseptic lotions, astringent lotions, and powders, without accounting for the costly days of disability.

To-day we bring such patients to the hospital, devote two or three hours to the initial treatment, keep the patient in the hospital eight days, and usually return it to work at the end of two weeks, or in three in cases of extensive wounds. In the former cases the scar was large, indelible, conspicuous; in the latter there is often no plain evidence that a wound has ever existed. The cost to the client is about the same in both cases, but in the

latter the money is earned by skill while in the former it was not earned at all; the patient would have been about as well off without any expert (?) interference; common everyday home treatment would have done just as well. In the former the patients were marred for life, while in the latter their full value is restored. In the former the patients were disabled two months, in the latter two to three weeks. Our plan of handling accidental wounds of the body is as follows:

1. RESTRAINT.—Even tractable patients always put up a pretty vigorous opposition against interference with a wound recently inflicted. They especially object to the suturing, and as wounds are often located where there is danger of the veterinarian sustaining personal injury, it is difficult and tedious to carry out the treatment without some form of effectual control. Much the best plan is to use the operating table. Removal to the hospital should be insisted upon where the distance is not too great. Here the patient will be well controlled and well positioned to carry out every detail from beginning to end. For outdoor work the standing position will be found better than casting harnesses. In the latter almost every wound is in an awkward position near the ground, difficult of access and in tiresome position for the operator to work so long. Some form of improvised stocks to keep the patient from lunging about, supplemented with a sideline or breeding hopples, may be made to answer the purpose. Then the operation may be made less painful by wiping the internal surface of the skin with two-per-cent cocain solution as far from the edges as the needle points will be located. This will greatly but not entirely control the pain of suturing. This same form of anesthesia may also be used when the patient is secured on the operating table. It prevents annoying struggles which raise dust and otherwise interfere with

the work. Respiratory anesthesia is not applicable because the operation is of too long duration.

For wounds on the legs we have found the casting harness better than the standing position because the legs are never well immobilized standing, and the surgeon is forced into a very uncomfortable bending position, particularly if the wound is about or below the knees or hocks.

In every form of recumbent restraint some care must always be exercised in letting the patient up without inflicting violence to the sutured wound. The forcible movements of the legs may stretch a sutured wound wide open by tearing either the sutures or the skin in which they are inserted. In taking from the operating table a horse that has just been sutured about the buttock, or which has been operated for shoe boil, we always keep the foot of the affected leg in the hopple until it lands safely to the floor and supports weight. Otherwise a swing might do much harm. For wounds of the legs treated in the casting harness ample protection can always be given against such injury by using plenty of bandaging material, and by helping the patient promptly to its feet without unnecessary struggles.

2. Disinfection.—We always try to begin this part of the treatment before securing the animal, by giving the body a thorough cleaning. Dried mud on the legs, feathers, and abdomen must always be curried and brushed off. Otherwise a veritable halo of dust will cloud the whole atmosphere when the patient is struggling during the operation. A good brushing and then a wiping of the whole body with a wet towel are essential. A preoperative bath where there are accommodations for such treatment would of course be better, but as animal bathrooms are not usually available, the above method of cleaning must answer the purpose.

The patient once secured, the first step is to shave the region about the wound. A good liberal field is shaved, not merely a narrow strip along the edges. As shaving requires previous washing of the hairs to soften them, the wound itself will become additionally soiled in this process by the lather and hairs falling into it, but as subsequent treatment will attend to this, little harm will be done. It is, however, not advisable to be unduly careless in this matter. By shaving first a narrow strip along the margin, drawing the razor away from the edge, much of this hair-soiling may be avoided. Hair-soiling can also be prevented somewhat by wadding the cavity with cotton while the shaving is being done.

In a large wound this shaving is no small undertaking, but in no case must it be omitted or slighted on that account.

The next step is to disinfect the shaved skin. Brisk friction with mercuric chlorid solution (1 part to 500 of sterile water) comes first, then it is painted with tincture of iodin, or, what is still better, a solution of iodin crystals in ether. Two drams of iodin to one pound of ether is the solution we are now using for skin disinfection. It seems to assure a better skin disinfection than does the alcoholic solution. It penetrates into the recesses of the skin better than the tincture, and thus effects a deeper disinfection.

The surroundings having been thus prepared, attention is now directed to the raw tissues. Here we find torn muscle tissue, shreds of fascia, nerves, vessels, subcutaneous areolar tissue, all more or less soiled. Every part of this motley surface is infected and there is no way of disinfecting it with chemicals if the wound must be closed. Strong disinfecting chemical substances that would be capable of killing the microbes now harbored on and within this anfractuous surface would also cauterize

it and thus produce a lot of debris that would have to be cast off by the healthy elements beneath. Such treatment is of course out of reason where the cavity must be bridged over with the skin. Ordinary antiseptic ablutions are inadequate; they never actually disinfect anything. Every attempt we have ever made to bring this surface of wounds into a safe state for suturing with solutions has ended in disappointment. Disastrous suppuration ensued and primary union of the skin was prevented in every case. So uniform was this result that we, like many others, fell back on open-wound treatment for a time as much the best and safest plan of treating practically all accidental wounds. It gave better results than the closing of wounds that were harboring infected tissues beneath the sutured integument. For a long time we only sutured accidental wounds for policy's sake—to appease a request—knowing all the while it was a useless procedure, and we always prepared for the inevitable breaking open a few days later, at which time the real treatment of the wound began.

We are now submitting such wounds to a *mechanical disinfection* we have called "uncarpeting." That is, we trim off all of the surface sheet-like, beginning above and omitting nothing save possibly a synovial capsule, large blood vessel, or an important nerve. These are, however, seldom encountered in wounds of this class. A sharp scalpel, scissors, and tissue forceps are used, and as the surface is loosened, the loose pieces are washed off by a stream of sterilized water poured from a pitcher by an assistant. The edges of the skin must be turned up where it is loosened from the body and its under surface submitted to the same trimming. Where there is nothing loose to trim off, the wound is scraped with the scalpel as the stream of water washes off the scrapings. The edges of the skin must be included. Sometimes simply

scraping them, at other times trimming them straight with the scissors, may be thought best, depending upon their condition.

A wound thus mechanically disinfected is a pure wound, as aseptic as a wound of the surgeon's own making, and it has a large, clean, disinfected field around it. In short, it is a fit wound to close up, and if closed properly it will behave in the manner that will please.

The wound cavity, having thus been ridden of all microbe-laden tissues, is a safe cavity to bridge over with the skin, but to prevent subsequent contamination provisions must be made to prevent accumulation of the serum that will exude from the walls. That is, the cavity must be drained. Serum must not be allowed to remain even momentarily in a wound cavity, for if this microbe food is offered, putrefaction of the serum, followed by infection of the living walls, is sure to follow. The certainty with which microbes creep into favorable places for their growth is now well known to students of aseptic surgery The favorable environment is as certain a source of infection as manual soiling. Mutilated, bruised, weakened tissues are prey for microbes, and when these are soaked in a serosity a few otherwise innocuous organisms may soon develop a formidable infection, while strong and only slightly injured tissues would destroy them. In short, when we create a favorable medium and an incubator, the microbes are usually there to do mischief, while on the other hand if we create unfavorable soils for microbian growth infections become negligible. These are laws in wound treatment, and they must be obeyed as sacredly as the laws relating to the sterilization of infection carriers, bands, instruments, and so on. Whether these infections of bruised wounds are endogenous or exogenous is less important to the practitioner

than the fact that they are very certain to occur in a large percentage of cases.

To better illustrate this point, the prevailing controversy in the medical profession over the open treatment of fractures might be mentioned to advantage. During the last few years the old, time-honored method of treating fractures of long bones by simple reposition and retention has been discarded by many surgeons for the new open method. That is, an invading incision was made into the traumatic cavity and the segments fitted together and retained with screws, nails, or plates. With asepsis as a protection against complications, it at first seemed this apparently sensible method would soon become the universal one for the treatment of fractures. Subsequent developments, however, proved that the plan was not entirely harmless. Many cases became infected with disastrous results. Why? Because a fracture with its injured tissues, blood-clots, outpoured serum, and impaired circulation is a favorable field for infection. To-day, on this account alone, the open method is being abandoned except in special cases. In veterinary practice the wound of castration might be used to illustrate the same point. The crushed spermatic cord, the accumulated clot and serum, and the closed incision combine conditions especially favorable for microbian growth. In fact, if any bacteria are deposited they are prone to develop a serious infection very rapidly.

We must, therefore, plan as perfect a system of drainage as possible in all wounds of this class, for otherwise our other good work will be useless. During the trimming process—that is, the mechanical disinfection referred to in the preceding paragraph—special care is taken to groove channels toward the proposed drainage orifice. This done, the skin flap is ready to be sutured.

Suturing the Skin Flap

At this stage of the procedure the veterinarian should don a pair of sterilized skin-tight gloves or else handle needle and thread with the needle-holder, with the aid of an assistant to keep the dangling end from trailing about over soiled places. The former method—the wearing of gloves—is the better, because suturing can then be done much faster and also more accurately. The first effort is to baste the flap with crucial sutures arranged somewhat loosely and about one inch apart, some care being taken to bring the flap to the place it actually belongs in order to prevent wrinkling and to avoid tension. This basting process is of great importance, because if it is well done the rest is a mere routine. The edges themselves are not yet approximated; there is a gap along the entire flap. An accurate approximation is now effected with interrupted sutures placed one quarter of an inch apart and about three sixteenths of an inch from the edges. Every fourth or fifth stitch of these interrupted sutures is made longer—about a quarter of an inch from the edges, or even more. The latter sutures are retaining sutures, like the crucial sutures, while the short ones are the real approximating media. The short sutures tend to prevent the infolding of edges that is sure to be produced by the longer ones. Infolding of the edges must be corrected at every point, as union is impossible unless the raw edges are brought into contact. Every part is thus closed up except the place planned for the drainage orifice. The size of the orifice or counter opening specially made must harmonize with the size of the traumatic cavity. A large wound will require a larger opening than a small wound, because a free outlet is essential.

In the short, interrupted sutures, which only pinch up the very edges of the skin, lies the secret of success. *The greatest error of suturing wounds of animals seems to have been that of putting in long interrupted sutures.* These prevent union by blocking the circulation, while the short sutures, which pick up only little bits of skin, permit the circulation of the blood freely to the very edges, where it is most needed.

The wound is now well repaired, and the skin flap is neatly approximated to the other edge of the wound without stretching. That is, there is no strain on the flap; it lies comfortably in the place where it properly belongs. There is, however, still some danger of damage from movements of the underlying muscles, despite this perfect apposition of the edges of the skin. This danger we reduce to the minimum by fixing the skin down to the body with Mayo's running loop, put in from one to three inches apart, according to the amount of strain to which the flap will be subjected by movements and edema. On prominent convexities of the body, such as buttocks or shoulder, there will be more strain than in flat places like the forehead or costal surface. In the former these loop sutures are placed close together; in the latter, they may not be needed at all. It is our judgment after several years of trial, in many wounds treated, that the resort to the use of Mayo's running loop is the greatest boon to wound suturing in animals. Without them we have failed even when everything else was done well and conditions were favorable. Since resorting to them we seldom fail to heal these wounds promptly.

For those readers who are not acquainted with this special suture, and especially for those who have no access to literature in which it is described, the following description is given:

"Mayo's running loop" is a series of continuous loops

that cross the wound line at a right angle. They are made to extend from about three inches on one side to about the same distance on the other. A full curved needle is armed with about two feet of single thread. Beginning say three inches from the wound line, the needle is passed subcutaneously or even deeper toward the wound, coming out three quarters of an inch from the point of entrance. One foot of the thread is drawn through. The dangling end is then tied with a double knot at the exit point, the knot lying upon the hole. Letting the end dangle again, the needle is now inserted through the exit point and brought out again three quarters of an inch toward the wound, where the dangling end is again tied in the same way. These are continued across the wound to about the same distance on the opposite side. The loops are not tied tight enough to block circulation but just tight enough to lie straight. When one is completed another is put in, one, two, or three inches away, and so on, until the whole field of skin is firmly recarpeted to the body.

It is almost a physical impossibility for a skin flap so fixed to break away from the body. Even when active inflammation follows, the flap stays fixed.

The drainage orifice, provided by leaving a dependent part unsewed or by making a counter-opening, is now wadded with an aseptic gauze wick. The first wadding should be tight so as to dilate the orifice. Subsequent waddings must be more loosely arranged to allow outflow of discharges.

We now "touch up" the sutures along the wound with tincture of iodin and then varnish the whole field with four or five successive layers of collodion. These thick applications of collodion play an important role in supporting the sutures, and they also afford a perfect cloak to keep out external soiling.

The patient must now be placed under restraint that will protect the wound against injury. Standing for ten days is always a part of this restraint, as there is no way to prevent stretching, tearing, and bruising a wound if the patient is allowed freedom. If the wound is located around the hips, thighs, hocks, buttocks, or croup, switching the tail must be prevented by sacking or tying it to one side. For wounds about the forequarters, neck, or head, it is best to back the patient into a single stall, fasten the head on the pillar reins, and feed from a hammock. Slings may sometimes be thought necessary to assure the desired state of repose that makes for good healing.

The after-care of the wound consists of daily attention to the orifice. This must be kept from damming up the discharges. A loose wick pushed up two or three inches is the best way to keep the drain working well.

At the end of ten days the collodion will be shedding. It will be found adherent here and there, but easy enough to remove by passing blunt scissors beneath it. The sutures are now removed along the edges, and if it is found there are some places not united, the loops are not disturbed for several days more.

If there is any doubt about the firmness of the union the patient must be kept in the standing position until the danger of breaking open the wound has passed. In twenty days such a patient is usually ready for the harness. A longer time may, however, be required where the traumatic cavity was large or when the wound is located at a flexion surface.

The reader might also be reminded that the treatment of such a wound is never complete without the administration of an immunizing dose of antitetanic serum. The closing up of a wound of this character creates a tetanogenic field, and as this certain preventive is available,

we are not justified in depending entirely upon our mechanical disinfection to prevent tetanus.

Wounds That Cannot Be Drained by Gravitation of the Discharges—Open Wounds

This group includes both the surgical and the accidental wounds located at the summit of a region. The traumatic cavity points upward and its bottom is too far from the surface of the body to drain downward. It includes the surgical wound of radical poll-evil operations and some operations for fistula of the withers, quittors, and all the accidental wounds of the back, loins, croup, and heels. Almost all other wounds besides these can be drained and treated by the method previously described. The surgical wounds of this kind are often invasions of badly infected places, but the aim of the operation in each case is to remove *en masse* the microbe-laden structures.

Thus in poll evil, although we start with a badly infected mass of tissue and tracts carpeted with infected granulations, when the operation is properly done all of these are safely removed and the cavity resulting, if not entirely sterile, is in a fairly good state for the easy destruction of the infection that remains. The same may be said of all operations of this character. The operation itself is the mechanical disinfection needed to promote healing, and the performance of the operations must be carried out with this end in view, for if we leave our surgical wounds, made in infected structures, without disposing of the original infection, or deposit more in operating, these wounds will be difficult to manage. They will heal slowly. The fact that we are operating upon infected structures is never an excuse for unclean surgery. These operations should be as clean as those

made in perfectly sound flesh, and in working through such operation we should keep in mind that the desired goal is to leave at the completion of the operation an aseptic traumatic cavity. With this accomplished, the subsequent management consists of disposing of the discharges which gather in the cup-like cavity as fast as they accumulate. What gravitation does in the wound previously described, we must now do by absorption. A large traumatic cavity will pour out an enormous amount of serosity between the second and fifth days. To dispose of this accumulation during these days is the prime factor in the treatment of such wounds, and as the healing period will be materially shortened if infection is controlled it is well worth while to work diligently at the task of absorbing discharges during this period—the first five days. Thereafter, as the exudation will gradually diminish and the walls will have protected themselves against invasion, this diligence may be somewhat relaxed. It is, however, well to keep all wound cavities as dry as possible until they are level.

The best method we have found to take care of discharges in large cavities is by smothering them with boric acid and iodoform (95 to 5 per cent). The cavity is filled with this powder, and it is renewed three times a day if it becomes soaked. While this vigilance may seem to be considerable trouble, it is always rewarded by prompt healing, and is much less trouble than that almost impossible task of handling the copious flow of pus over the surface of the body, sometimes encrusted an inch thick from withers to heels, constituting about the most unsavory postoperative condition imaginable. The difficulty in handling this latter condition is enormous compared with the little trouble necessary to prevent occurrence by diligent, initial attention, lasting four to five days. Furthermore, traumatic cavities of this nature

that are not allowed to become infected, never overfill with exuberant granulations—when the cavity is filled the granulations are already maturing into firm tissue.

The use of gauze for the purpose of absorbing secretions in wounds that cannot drain has not given us the same satisfaction as the absorbent powder above mentioned, and is applicable only in small wounds and especially in wounds of small animals.

Boric acid will take up large quantities of wound discharges and may be depended upon to preserve from putrefaction any serum it thus absorbs, while iodoform, kept continuously in contact with the walls of a wound cavity, will disinfect them better than any other known chemical.

In accidental wounds of this group the practitioner should choose one of two lines of treatment. The first begins with mechanical disinfection as described for wounds preparatory to closure and is followed up by keeping the wound aseptic with boric acid and iodoform while the cavity is filling up. If the granulations threaten to overgrow, there is nothing better to control them than plain white lotion.

The second method begins with a disinfection with a strong chemical substance that will not only destroy the microbes but will also cauterize the tissues into a firm protective coating of dead elements. Both of these plans are good because each first disposes of the surface infections that would soon do mischief. The former is the more refined, the latter the more practicable for veterinarians. Whenever a veterinarian cannot or will not for any reason surgically disinfect an accidental wound that he decides to treat as an open one, he should apply to it a chemical substance that will *do* something and not merely delude himself into believing that any ordinary antiseptic wash will be of material benefit. Strong

proprietary liniments often gain wide reputations as wound medicines because they are actually germicides. The fact that they temporarily retard healing by cauterizing the surface is in their favor because they destroy everything they touch, and because they produce a leathery coating that gives protection against subsequent infection. Wounds thus treated escape the surrounding phlegmonous condition of infection, and when the eschar desquamates, the cavity is found paved with a layer of rosy, healthy granulations that need but little further attention beyond a weak antiseptic powder or mild astringent.

What chemical substance should the veterinary practitioner select for this purpose? In other words, what is the best application for an open wound? Pure phenol, butter of antimony, and chemically pure nitrohydrochloric acid are strong substances to consider in this connection, but they are exactly the kind of chemical to use. Applied with a brush, with precautions against overflow, these substances will do no harm. A little discretion to avoid the cauterization of synovials, nerves, and large blood vessels should of course be practiced in the use of such radical measures, just as the surgeon would avoid cutting these with the scalpel.

A good lotion, less potent than the above but one that will, however, answer the purpose, consists of one ounce of permanganate of potash and two ounces of sulphate of zinc, dissolved in a quart of water. This can be applied two or three times daily until perfect disinfection is assured, or a wad of cotton, soaked in the solution, may be bound to the wound and renewed frequently.

Kerosene is a mighty good disinfectant of raw surfaces if applied frequently during the first few days, and it is perfectly safe if it does not touch the skin.

In fine, open-wound treatment must begin with disin-

fection of the exposed raw tissues. If this is not done surgically, in the manner prescribed for mechanical disinfection, then let the veterinarian throw precedent to the winds and "go at" his wounds with chemicals that will do this work for him.

Venomous Wounds

This term is coined to meet the requirements of the particular scheme of treatment already laid down in the preceding paragraphs. By it we wish to distinguish wounds in the active stage of inflammation. A venomous wound is one invaded with bacteria and envenomed with their toxins. The term "infected wound" is somewhat different, since a wound is infected as soon as bacteria have lodged upon it; it is, however, not envenomed until these bacteria have injected it with their poisons. The term is used to designate that period of infection intervening between the time the tissues begin to react against the bacteria and their poisons and the final cessation of the active inflammation. In short, it applies to all wounds in the siege of active inflammatory processes. When the inflammation subsides, cicatrization proceeds normally, unless there is some permanent damage done to a bone, a tendon, a ligament, a cartilage, or an undrained cavity has formed. These events may cause a chronic suppurative process—a fistula. When the active inflammation ceases, or a chronic state of suppuration supervenes, the term "venomous wound" no longer applies.

When a wound is soiled (infected) and before there is any inflammation—that is, during the first twenty-four or even forty-eight hours—we have recommended the unceremonious trimming off of the bacteria-laden tissues. That is, we have advised the immediate creation of an aseptic wound from a badly contaminated

one. To resort to the same measures in a venomous wound would be an error fraught with much havoc. Surgical interference with a wound in the active stage of inflammation (a venomous wound) is capable of doing harm by opening up new channels for invasion and thus exciting rather than subduing the inflammatory process. The mechanical disinfection — uncarpeting — previously referred to for soiled wounds is not recommended in the treatment of venomous wounds. When bacteria have already injected the tissues with poisons and have themselves invaded more or less deeply into the tissues, mechanical disinfection is no longer indicated. That is to say, when a wound already shows a pronounced local reaction of swelling, pain, redness and probably a systemic febrile reaction, it is too late to transform it at once into an aseptic wound. We must now manage it in another manner. Radical extirpation or amputation may be called for when a venomous wound actually threatens life, but such measures are rarely expedient in animal surgery.

The evacuation of purulent collections, from the hotbed of the infected center, and the trimming off of elements actually dead, are the only surgical treatments to which a venomous wound should be submitted, and these measures should be carried out carefully so as to inflict as little injury to the inflammatory surroundings as possible. If we meddle too much with an inflamed wound a more and more serious state is produced. *An aggressive attack upon an inflamed trauma is always harmful.* When such a wound has been evacuated of its purulent collection and the accessible dead elements have been removed, the advancing process must be left largely to the reactive forces of the body. Antiseptic packs covering the wound and the swollen environs is a standard treatment. In humans it is never omitted, and the

antiseptic, that is now receiving the most favor, is a saturated solution of aluminum acetate. Boric acid solutions and lead acetate solutions are also highly recommended. There is little doubt that such packs are helpful in animals as well as in human beings, but with us they are seldom renewed often enough to be of real service; when a wound is discharging copiously, they tend more to do harm than good, unless the packing material is changed as often as it becomes soaked with pus. Furthermore, the wrapping must not be so tight as to dam up the discharge. To apply an antiseptic pack upon a badly discharging foot, for example, and leave it to become soaked with serosity during the succeeding twenty-four hours, is not good treatment. On the other hand, if the entire covering were changed three or four times a day, a certain amount of good would accrue from such treatment. Hot antiseptic baths —a popular sort of treatment in the veterinary profession—are seldom continued long enough, or done clean enough, to be of much service. In short, I doubt very much whether any form of local antiseptic treatment with solutions as they are usually used on animal patients ever turns the course of any local infection. The process goes on in spite of such treatment, and the patient sinks or swims on its own inherent vitality. It is therefore evident that the best recourse we have is the surgical measures above recommended. For example, we could bathe the scrotum in cases of castration-funiculitis hour after hour, and day after day, without any good effect, but the moment the incision is opened and the collection of pus drained out, the patient's temperature falls, and it is soon on the high road to recovery. This is the case with practically every venomous wound with which we have to deal; analogous cases may be cited *ad infinitum*.

In discussing the management of venomous wounds, along this vein of non-interference, I was once chided by a student for performing the radical operation for infection of the navicular sheath from a nail prick, on the ground that my arguments and practices were discrepant. When the objects of this operation are analyzed, however, it is made plain that the whole procedure is nothing more than the drainage of a pent-up seropurulent collection in the sheath cavity. The apparent radical part of the operation is the invading dissection required to reach the hot-bed of the infectious wound.

Wiping out venomous wounds frequently with clean wads of cotton, keeping the surroundings free from desiccated discharges and dusting freely and often with an antiseptic (non-astringent) powder I have found to be the best, and the most practical treatment.

The resort to bacterins should not be ignored; the best surgeons are using them. In one of the largest surgical clinics in Chicago a bacterin is made in every pus case, and as this practice is now of some years' standing, it is very evident that benefit is derived from the bacterins, for otherwise the practice would long since have been discontinued.

Whenever suppuration continues beyond the active inflammatory stage, after all local and systemic phenomena attending the process have ceased to exist, then the wound treatment must be directed toward the underlying cause. Foreign bodies, sloughs, sequestra, exposed ligaments, tendons, cartilage and tooth roots, channels between layers of muscles, or outer integument extending in a downward direction, are a few of the many things capable of perpetuating a suppurative process. It is the surgeon's duty to "hunt these out" and to correct matters whenever any of these elements are found to exist.

Treating suppurating tracts day after day and week

after week with antiseptic infections is useless, until the cause of the suppuration is removed. This, of course, is elemental and well known, but is well worth repeating. Sometimes it is not advisable to operate too early after the acute inflammation has receded because the process of sequestration may not have progressed far enough to enable one to cut out all that will eventually amputate itself from the living tissues. Thus a suppuration supervening a calked coronet points to quittor, but if we operate at once there is found no guide to the area of necrosis in the cartilage. After a little procrastination the necrotic area will become distinguishable from the healthy surrounding and can be removed successfully. The same may be said of suppurating processes due to exfoliation of bone particles. If a hasty reaction is made, separation is not complete, and a second operation will be required.

Approaching the final stage of healing, venomous wounds do not behave as well as aseptic wounds. The granulations of an aseptic wound grow safely and evenly to maturity like a healthy tree, while those of infected wounds are erratic in their behavior. Some may become indolent and others exuberant. Indolent granulations (ulceration) are rare in animal wounds except from improper treatment—treatment that stunts them. The continued use of strong antiseptics or the too early resort to astringents (alum powders, for example) are very harmful to wounds. They prevent the cells from growing toward a healthy maturity and delay healing. Astringents are not indicated until the granulations are level with the surface of the body; then they are needed to prevent the formation of a protruding scar. Common white lotion or white lotion with the addition of a small amount of copper sulphate is hard to improve upon as an astringent for the last stages of sclerogenesis.

Methylene blue, tannic acid, or alum are also effectual, but these are not indicated in cavities. They do no good in such locations and often do much harm.

The growing custom of using alum mixtures indiscriminately as a stock healing powder is not good practice, as such strong astringents applied to wound cavities prevent instead of encourage the formation of new tissue. Alum or any other astringent application is indicated only as above mentioned, to prevent overgrowth of granulations.

Another element of no small importance in the treatment of venomous wounds is absolute rest of the inflamed part. Movements of inflamed wounds is disastrous, while quietness is very helpful. Keeping animals tied up instead of giving them the freedom of a paddock, tying them up instead of exposing wounds to the movements of getting up and lying down, applying immobilizing bandages or leg braces, are just so many means of preventing harmful movements of infected regions. When a human surgeon puts a patient with an infected foot to bed, or places an infected hand or arm in a sling, he is doing a service that he knows is more beneficial than all the other treatment he is able to devise. The same must not be forgotten in the treatment of brutes that never show any inclination whatever to protect their wounds against movements or even serious violence.

Internal treatment for venomous wounds is usually directed at the fever, the pain, the emunctories, or the infection itself. This calls for antipyretics, analgesics, diuretics, purgatives, and internal antiseptics. When a venomous wound threatens to be mortal, a simple line of such internal medical aid should be carefully planned. In the early stage when the pulse rate is high and the character full and bounding, a few doses of aconite has a helpful quieting effect on the circulation; later quinin

in small repeated doses seems best. I have never actually discerned any benefit from ecchinacea or any other internal antiseptic. Potassium iodid, in an article entitled "The Systemic Handling of Wounds," by Prof. W. L. Williams, is highly lauded as helpful in controlling the ravages of infections. Analgesics are seldom called for in animals. Given in sufficient dosage to allow suffering patients a few hours of rest, they are always apt to produce delirium or a blunted state that is prone to do more harm than good by causing the animals to inflict physical injury to the infected region. Purgatives must be administered cautiously, as an uncontrollable diarrhea may ensue upon the administration of a purge or even an oleaginous cathartic in herbivora. In carnivora a good saline is always indicated, and in these animals it may be preceded with a cholagogue of calomel with good results. Among the diuretics best suited for this purpose is acetate of potassium given once a day during the period of active inflammation. As for internal antiseptics for wound sepsis, "there ain't no such animal" so far as the writer is aware. A drug that would actually destroy focal bacteria, inhibit their activity, or in some way dispose of their metabolic products, would be a blessing *par excellence,* but unfortunately agents capable of performing this feat are yet undiscovered.

Punctured Wounds

A punctured wound is always more dangerous, or rather more treacherous, than one with a wide open cavity, because anaerobic infection is more grave, or at least more uncertain in its terminations, than facultative or aerobic infections. The punctured wound is also grave because of the inaccessibility of its remotest point to direct treatment. If the bottom of a punctured wound could be reached for an effectual trimming that would

bring out every vestige of the soiled tissue, it would be no more dangerous than other wounds, and when the invading incision required to accomplish this mechanical disinfection seems feasible, much the best plan of punctured wound treatment is to get right down to the bottom of things and clean out the whole tract at once. When this is not feasible, the tract should be opened as far as possible and the rest cleaned out with the curette and then submitted to a prolonged irrigation with a weak antiseptic solution or else cauterized with a carbolic swab. Cauterization should, however, never be practiced unless it is positively assured that the very bottom will be reached, because such treatment may actually form a better cloak for anaerobes that survive beneath the eschar. A splendid example of punctured wound cauterization is the application of muriatic acid to nail punctures of the feet of horses. If the tract is shallow, and the acid reaches its depth, the wound heals promptly and the plan (generally carried out by horseshoers) is given a boost. On the other hand, when the tract is deep and therefore only partly cauterized, a serious suppurative or gangrenous inflammation is sure to supervene, and if the patient escapes these, tetanus may follow later.

For the punctured wounds of large dimensions penetrating the large muscles of the chest, buttocks, and neck of animals, usually sustained by collisions with broken stalls, fences, or vehicles, the best form of sterilization is a prolonged irrigation. The tract of such a wound contains torn muscle, shreds of fibrous tissue, blood clot, and hairs and dirt carried in with the wounding object. It is impossible to manage these because of their inaccessible location except by washing out everything that is loose and cleaning everything that is attached, by a diligent irrigation. An attempt should be

made to deposit a hose, small enough to allow reflux, back to the very bottom of the tract, and then with a fountain syringe or hydrant irrigate the tract for several hours. Pure water, physiological saline solution, or a weak antiseptic should be used. A perfunctory treatment of this kind will not do much good, but a prolonged, carefully done irrigation may perfectly sterilize such a wound.

The following case serves to illustrate: A horse sustained a puncture by a broken shaft of a single wagon, extending from the breast to the level of the olecranon. Having determined the location of the bottom with a long sound, a counter-opening was made through the skin behind the elbow. A hydrant hose was placed in the counter-opening and a good stream was turned on for four hours. Besides peppering the two wounds with an antiseptic powder several times a day, no other treatment was given after this one irrigation. In spite of the great dimensions of this wound there was never any suppuration and the patient returned to work in exactly three weeks, entirely healed up. The success here was due to the perfect sterilization by the long irrigation. Whenever such irrigations are attempted, provisions must always be made for a free reflux of the water by using a hose of smaller caliber than the tract, otherwise infected material might be driven into the tissue spaces far beyond the original wound.

For smaller punctured wounds that can not easily be mechanically disinfected, a loose antiseptic wick should be inserted along the whole tract and changed frequently. This may be preceded by injections of hydrogen peroxide.

Finally, a dose of antitetanic serum is given in all punctured wounds to prevent tetanus. The dose should vary from 500 to 1,500 units, according to time of ad-

ministration. On the first or second day 500 units will answer, but when the wound is older, 1,000 units to 1,500 units will be required to assure immunity.

Gunshot Wounds

We shall not attempt to describe a treatment for all of the various wounds capable of being inflicted by firearms. Their varieties forbid in a short review of wound treatment, and the writer, like probably all American veterinarians except a few in our army who saw service in the Philippines, must plead inexperience. As the fund of information in this connection is about to be enlarged by the untold range of experience and observation of our European confreres, it would be presumptuous for one in my position to venture into this domain at this particular moment.

In peace times veterinarians only rarely encounter wounds made by firearms, and when they are met they are generally from low-power guns or shotguns. These, of course, inflict wounds of a different character than those of high-pressure rifles used by modern armies, saying nothing of shrapnel, shells, bombs, grenades, etc., included in their ordnance. It is the wounds of these modern arms that interest us most to-day, and as peace may not always be our good fortune, it stands us in hand to acquaint ourselves with the present experiences of the able veterinarians of the European armies now in the field.

At present I shall content myself with a few simple recommendations. The old custom of immediately searching for a bullet imbedded in the body has long since been abandoned. It is only the plainly felt subcutaneous bullet that is removed to-day. Those lodged deeper, even though they may have been located by the Röntgen rays, are left strictly alone to become encysted or to form

an abscess. In the latter event, the bullet is removed when the pus of the well matured abscess is evacuated. "Do not search for bullets unless they can be clearly felt through the skin, but leave them to the tissues where they will either be tolerated or expelled by suppuration." (Cadeac.) Thus Cadeac in a word says about all there is to be especially said about extraction of bullets. The tract of the bullet is not irrigated, nor is there any effort made to explore its depths. Local antiseptic treatment of the orifice to avert secondary infection is, however, faithfully followed and the patient is watched continuously for febrile complication and for the abscess that will disclose the location of the bullet. Antitetanic serum is always indicated, and should never be omitted, in the management of firearm wounds.

WOUND HEALING

By A. T. KINSLEY, M.Sc., D.V.S.

The subject of wound healing is not new. It has been discussed by eminent pathologists and surgeons for hundreds of years. This, like some other problems in pathologic surgery, appears to especially attract the attention of the general medical profession periodically and spasmodically. Thus Lister's principles of antiseptic dressings and aseptic surgery caused marked modifications of methods in wound treatment and resulted in a great advancement of surgery. Yet Listerian principles are not so universally employed by veterinarians as they should be. The reason for the existence of this state of affairs is difficult of explanation.

Bacterins an Aid in Wound Treatment

Recently, following the lead of medical investigators, another advancement has been made in the knowledge of wound healing. This newer method consists of increasing the animal's resistance to infection by the stimulation of its tissues to form specific opsonins. Opsonic therapy is and has been increasing the possibilities of surgery and rendering all major operations less hazardous.

Wounds and Their Classification

A wound may be defined as an interruption of the continuity of tissue or tissues. Some have restricted the term to those conditions resulting from traumatism. Others have confined it to injuries of soft tissues, while

still others maintain that wounds occur only upon the surface. There are no good reasons for these restrictions, because thermic and chemic influences produce interruption of tissues which are not unlike and are not distinguished from wounds mechanically inflicted; again, a fracture is a break in the continuity of osseous tissue and is repaired in exactly the same way as is a wound in soft tissue; and further, a rupture, as of the liver or spleen, is characterized by tissue destruction and interruption of the continuity of the integral parts of the injured organ, all of which are conditions not easily differentiated pathologically from wounds. Usually the term "wound" is restricted to those injuries that are produced by sudden violent action; thus ulcers and necrotic tubercular centers are not wounds. A bruise may or may not be a wound, depending upon the nature of the lesion; that is, whether or not an interruption of the tissue has been effected.

There are a variety of ways of classifying wounds, of which the following will serve for discussion: Etiologically, wounds may be traumatic, chemic, or thermic; topographically, wounds may be surface or subsurface, and again they may be facial, cervical, thoracic, abdominal, and so on. According to character, wounds may be incised, punctured, lacerated, contused, as produced by a stab, shot, or bullet, or a bite. As to condition, wounds may be infected or non-infected.

How Wound Healing Is Accomplished

Wound healing is the simultaneous regeneration of the tissue of an area in which there has been previous destruction. Traumatic wounds usually heal more readily than wounds resulting from thermic or chemic causes, because traumatisms are the result of mechanical force

only, and the destructive influence ceases immediately upon removal of the cause, whereas the influence of thermic, and especially chemic, causes continues for a variable period.

Many methods of wound healing have been described, such as immediate union, primary union, secondary union, tertiary union or intention, healing under a scab, and so on. When the exact conditions are understood, it is found that practically all wound healing is of one or the other of two types, primary union or first intention, and healing by secondary union or granulation.

The process of healing by primary union embraces coagulation of the hemorrhagic extravasate, agglutination of the wound margins, hyperemia, inflammation, vascularization, fibrous formation, disintegration of the hemorrhagic extravasate and inflammatory exudate, cicatrization, epithelization, and substitution, the time required for the latter being much greater than the former.

The other type of healing—that is, by granulation—is the type usually observed in the majority of wounds in the domestic animals. It is this type in which there is a continued infection and a continual destruction of the newly generated tissue, thus necessarily increasing the length of time required for the wound gap to be filled with new tissue. This type of wound healing can be obtained by any one and under any conditions surrounding it. It is certainly no credit to a veterinarian to have under his care several cases of wound healing in which the method of healing is by granulation.

Prevailing Methods Deplorable

Healing by primary union is desirable in all wounds. Unfortunately, this method of wound healing is not obtained as frequently as it should be in veterinary practice.

The majority of practitioners have thus far not attempted to obtain primary wound healing in any except small surgical wounds. Often surgeons do not properly prepare their fields of operation and do not give the proper care and after-treatment of surgical wounds to favor this type of healing. This is deplorable, and is one of the most frequent causes of condemnation of veterinarians. Why veterinarians take no more pains than they do to observe antiseptic precautions in their surgical operations is difficult to explain. Most practitioners make the plea that they have not the time to do aseptic surgery, and that their clientele will not pay for this kind of operation. Such surgeons are really to be pitied, for it is indicative of improper understanding of aseptic surgery, as well as showing that they have failed to impress their clientele by their surgical efficiency.

Advantages of Good Surgery

If a surgeon will successfully perform two or three aseptic surgical operations, in which the wounds heal by primary union, he will have no difficulty in obtaining future cases and a good fee for aseptic surgical operations in the same community. It is not an impossibility and, further, it is not difficult to obtain primary wound healing even in large lacerated wounds. Certainly, time is required to prepare the wound, but after the first dressing little, if any, attention is required, and the advantages obtained more than offset the extra time required in placing the wound in such a condition that it will heal by primary union. This type of healing is rapid, and seldom leaves an unsightly scar; thus the animal is back in service in a very short time. The value of the animal is not then depreciated by unsightly scars, and the actual time required of the surgeon is

less than it would have been had he permitted the wound to remain infected and thus require daily treatments.

Aseptic Surgery and Wound Dressing

Large lacerated wounds are properly prepared by first shaving the hair from all adjacent tissues, then thoroughly cleansing the wound and marginal tissues and removing all fragments of tissue, after which the wound margins are brought in apposition and maintained in a fixed immobile position. The method of procedure that should be resorted to in cleansing a wound prior to bringing the various parts of it in apposition with sutures or otherwise, should be determined by the nature of the wound. In a lacerated wound in which there has been introduced filth, such as dirt, fecal matter, and hair, the parts should be thoroughly washed with physiologic salt solution until the filth has been entirely removed. The tissue shreds should then be removed by the use of sterile instruments, and some disinfectant used in further cleansing the part. The application of the disinfectant should be again followed by washing with sterile physiologic salt solution, for be it remembered that if disinfectants are applied tissues are destroyed, the extent of which will depend upon the strength of the disinfectant and the duration of its application; the purpose of the application of the disinfectant is to insure the destruction of all infectious agents, and the object of the application of the salt solution after the disinfectant is to wash away all excess disinfectant.

Such treatment of a wound will necessarily require considerable time. I have seen some such wound treatment, and in one instance I remember where the irrigation with the salt solution was continued for four to five successive hours. In this wound some thirty sutures were

taken, the wound healed by primary union, and the animal was back in service within a week.

If a lacerated wound is fresh and clean, thorough irrigation for from thirty minutes to two hours with a salt solution is preferred without the application of a disinfectant.

After the wound is thoroughly cleansed, the various parts of it may be adjusted, the kind of suture and the method of suturing depending upon the nature of the wound, always selecting that type of suture which will hold it in the best position with the least destruction of tissue. When a wound is sutured, especially if it is of large size, it is necessary to provide it with drainage.

In the treatment of granulation wounds of long standing, it is possible in many instances to render them aseptic and bring the wound margins in apposition, thus inducing primary union. In some instances, however, there is so much tissue destroyed that it is impossible to obtain immediate union, even though the wound is thoroughly cleansed.

Antiseptics Often Misused

There is no question but that the application of antiseptics as frequently practiced is harmful, and that the tissues are often injured and wound healing retarded by the application of such agents. Wounds are protected by the inflammatory exudate which usually oozes to the surface, thus favoring granulation, which ultimately results in the filling of the gap and completing the union of the tissues, the time required being much less than if tissues are repeatedly destroyed by the frequent application of antiseptics.

REPAIR OF WOUNDS[1]

By WILLIAM BRADY, M.D., Elmira, New York

The general management of wounds should be based on a practical knowledge of the physiology and pathology of repair. With a thorough understanding of the process of healing the young tyro may bring about the cure of old varicose or other ulcers which his senior colleagues have perhaps pronounced incurable after years of empirical tinkering with various highly recommended ointments. Without going into details, a brief consideration of certain features of the healing process may be of interest.

In a wound not aseptic, inflammatory symptoms are apt to appear on the second day. Every case should therefore be seen at this time, whether the dressing is to be disturbed or not. It is often wise to leave a strand of silkworm or gauze in the lower angle of an accidental wound of whose asepsis there is much doubt, and to remove it on the second or third day if the wound is clean. The best dressing for such a case is the wet normal salt gauze, which is undeniably superior to dry gauze or ointments as a medium for drainage for exuding serum.

Sutures, if inserted, should be removed on the fifth day if there is no tension upon the edges of the wound. If tension is unavoidable, the sutures should remain until about the tenth day. It is generally well to reinforce, or even replace, suturing by adhesive strapping to relieve undue tension. A wounded extremity is always more at

[1]Reprint from *Medical Summary.*

rest in a flexed position, if such position does not cause gaping of the wound. Absolute rest is best attained by means of suitable splints, or firm bandages in wounds of sufficient importance to require it or make it advisable.

The floor of a deep laceration, as of the perineum, becomes covered after several hours with a varnish-like glazing of coagulated fibrin from the exuded serum. Suturing at this stage will ofttimes give first-intention union even better than primary suturing.

If not closed, an open glazed wound becomes covered in two or three days with a dirty grayish membrane, which separates after a few days and is discharged with the pus, leaving a base of bright red granulation tissue. Granulation tissue is the vascular framework upon which cicatricial tissue grows. When it reaches the level of the skin, a transparent, delicate film appears around the edges and extends gradually out toward the center of the granulating surface, like ice freezing over a pond. This film is, of course, new epithelium, though I have seen nurses and doctors carefully wiping it away with wet gauze or cotton in the blissful notion that it was foreign material.

New epithelial cells are as readily destroyed by chemical antiseptics as are pyogenic bacteria. There is not only no excuse for washing a healing wound with germicides, but positively a contraindication to such maltreatment. Asepsis, not antisepsis, is the goal to strive for.

Granulation tissue in large wounds or ulcers aids repair also by contracting and drawing the edges closer together. This gives us a valuable hint for the use of adhesive plaster about larger granulating surfaces. As to strapping directly upon the granulations, personally I have had only unpleasant results.

A wound whose edges are not approximated may still heal without suppuration if it be filled with aseptic blood

clot, and kept aseptic—that is, left alone. A clean clot is an excellent culture medium for embryonic epithelial cells. As healing progresses, a portion of the unabsorbed clot is pushed out by the granulating tissue and dries in a scab which protects the surface of the wound. Aseptic clot repair occurs typically in simple fractures, subcutaneous tenotomes, internal rupture of organs, and healing of bone cavities following the radical operation on sequestra. It is nature's peerless method, and one that we should endeavor to imitate whenever the conditions permit. No other packing is as good as clean blood clot. No other wash is as good as blood serum.

Given a recent wound of accidental nature, how shall we render it aseptic? In ordinary cases one thorough cauterization with iodin is usually sufficient, all subsequent dressings to be without antiseptics of any kind. In wounds which give rise to the fear of tetanus or rabies, however, pure phenol is preferable. If the wound has a cavity, the phenol should be poured in after moistening the surrounding skin with alcohol, and allowed to remain one minute. It may then be removed with a dropper, and alcohol applied. If it is a puncture wound, the phenol must be applied on a cotton-wrapped probe, opening the track of the puncture if necessary to permit access to the farthest point. If it be a freely-bleeding wound, and still bleeding, I believe cauterizing is unnecessary under any conditions.

Many authorities are now reporting happy results from leaving granulating wounds and ulcers freely exposed to the air, under a wire netting for protection against insects or injury. Some writers report excellent results from treating skin grafts in this manner.

Brewer's yeast is a remedy I have found very useful for hastening the separation of old sloughs and stimulating granulations. It smarts a trifle, but patients do

not object to it, especially when they find they can obtain it for the asking. I have also given it in doses of one to two ounces internally, though with doubtful effects.

For painful wounds and ulcers generally a simple dressing kept wet with warm normal saline solution seems most useful. The patient appreciates it better if he is given normal salt tablets (which, by the way, make real imitation plasma), rather than being directed to dump a teaspoonful of common salt into a dish of water.

For ugly, painful old varicose ulcers a boon to the new doctor on the case is orthoform, applied either as a dusting powder or in five-per-cent ointment. Some patients will develop erythema from orthoform, much like those formerly common when iodoform was in use.

For exuberant granulations—"proud flesh," as patients seem to call it—I like the scissors. It can usually be trimmed off without discomfort. If this is not permissible, then firm pressure is the next method of choice. My experience with silver nitrate has been uniformly unsatisfactory. So far as I can see, silver nitrate merely musses up the field of operations and stimulates the granulations to renewed activity. The clean, prompt, effectual way to remove proud flesh is to cut it down.

Carbolic acid, in any other role than as a cauterant, is to be mentioned only to be condemned. There is nothing known to domestic surgery that will delay healing of a simple wound like carbolic salve, unless it be a fresh and reeking poultice of genuine cow dung.

Antiseptics, other than cauterants or recognized disinfectants, might well be discarded from the office altogether. We have little use for them. Once having asepticized a wound, I am sure the best policy from that point on is to avoid antiseptics and depend wholly upon

simple cleanliness, with due regard to the all-important consideration of the patient's opsonic immunity and general condition.

Vaccine therapy and internal medication are chapters by themselves. Our chief duty is to stand by fully armed while nature does the work.

In dry old varicose ulcers, carbuncles with little fluid drainage, and indurated swellings of various kinds in which incision is not productive of the usual benefit, the engorgement and coagulation of lymph in the vessels about the lesion is probably preventing free access of fresh opsonins or antibodies to the site of infection.

Wright and others report good results in such cases from the use of citric acid internally in sixty-grain doses every three hours until a freer exudation of serum is obtained from the wound. The local use of citrate of sodium and salt solution is also advised—one tenth of one-per-cent citric acid and four-per-cent sodium chlorid wet dressings.

One case of Ludwig's angina, reported by Sir Almroth Wright, seemed hopeless despite free vertical incisions in the neck and a measured opsonic index of 1.8, there being serious physical prostration and insufficient exudation from the incisions to enable Wright to "fill a platinum loop" for culture. Yet two or three doses of citric acid, as mentioned above, resulted in free oozing from the incisions and immediate institution of convalescence. As Wright says, it was not the patient's lack of resisting power, not his need of vaccine treatment (as shown by the opsonic index), but merely the choking of the lymph vessels about the induration which prevented his ample supply of antibactericidal bodies from reaching the Streptococci in the wound or lesion, and bringing about recovery.

SURGERY IN WOUND TREATMENT [1]

By JOHN ERNST, D.V.M., Salt Lake City, Utah

Wounds are generally understood as being a solution of continuity. They belong to the division of medical science known as surgery. This does not allude to operative surgery alone, but includes such medical agents as may be or are applied, with a view or for the purpose of accomplishing certain specific results. It is said that "it ought to be, as a matter of course (perhaps it is so in point of fact) that no one of intelligence and integrity will assume the duties and responsibilities of surgical practice without the due preparation and equipment, which is only to be acquired by conscientious study and complete knowledge of medical science at large."

Especially and indispensably, a surgeon must be an accomplished anatomist. His knowledge must be thorough in the several divisions of anatomical science. He must possess a familiar acquaintance with descriptive anatomy; he must be fully instructed in surgical anatomy or the anatomy of regions; he must have mastered the last chapter in pathological anatomy; and if there are any other kinds of anatomy he must master them all, and then he will have become an anatomist in fact and qualified to practice surgery. Yes; a surgeon must be an anatomist, and it ought to go without saying that only a surgeon should practice surgery, whether his patient be biped or quadruped. No untrained layman should presume to wield the knife and the cautery with their associated arsenal of weapons and their appli-

[1]Read at meeting of the Utah Veterinary Medical Association.

ances for the subjugation of the enemy whose assaults it is the special provision of the surgeon to repel. An ignorant operator may easily become, himself, a more dangerous "lesion" than some of those which we presume to treat. The man who can cut into the living and usually hypersensitive flesh of suffering animals, without knowing what tissues or organs he is attacking, what arteries he is likely to sever, what nerves to wound, what organs to lacerate, what functions to paralyze—such a man, if he be found, should simply be subjected to an odium which should ostracize him from honorable and equal association with other of his species, besides being held criminally amenable to the law providing penalties for the perpetrators of cruelty to animals.

These reflections may be unnecessary, but it is all too true that our domestic animals too often become the victims of worse than brutal masters, who take advantage of their helplessness and inferiority to inflict upon them cruelties so gross and aggravated that right-feeling men are often compelled to blush to call them fellows. It is no excuse for this that it is done through the agency of a pseudo-surgeon; such a plea merely doubles the number of the wrongdoers.

With the skill of the expert anatomist must be associated, of course, the necessary mastery of therapeutics, and a familiar knowledge of special and general pathology, and all should be supplemented by a knowledge of the theory and practice of the farrier.

The science and the application of the laws of hygiene, so generally, indeed almost wholly, ignored by our fathers, and so largely a discovery of the present time, should never be overlooked or depreciated by the genuine surgeon. The fullest attention to the theories and applications of what may be denominated the science of antisepsis, now so universally and unintermittently an

adjunct to all medical and surgical practice and so utterly indispensable in the departments of dressing and nursing, and so often an available and valuable aid in the very act of operating, must be considered to have become an incorporated and constituent department of the domain of surgery and medicine as well, and the cultured veterinarian will, of course, so regard it in his practice.

Besides the special scientific attainments to which we have referred, there are many other qualifications which must enter into the character of the good and skillful surgeon, in order to round it into true symmetry and proportion. Bouley remarks that "he must not only be a man of science, but a man of art," meaning, we suppose, that he should not only possess knowledge but know how to make it available. First, he must possess the faculty of knowing how to gauge the necessity of his interference, with its manner and its duration; or, on the other hand, whether any interference is necessary, and whether the true indication is not to refrain from active measures. The result of his decision will afford a good test and gauge of the extent to which he has profited by his clinical and theoretical study. He is a wise philosopher who can wisely determine when to let alone in opposition to the temptation to do something. Courage and coolness, with patience, are essential qualities of temper in an operating surgeon. To become alarmed and lose his balance on the occurrence of some untoward incident, or the appearance of some unlooked-for abnormal development or complication, or to give way to a spirit of impatience because of unexpected delay, or, especially, to resent the fractious movements of the suffering animals writhing under the knife or the glowing cautery, is both unprofessional and unmanly. The terms, courage, coolness, patience, and kindness should describe his state of mind while operating.

Every movement of the surgeon should be prompt and precise. Indeed, by operating rapidly he shortens the duration, and consequently the sum, of the pain, and thus diminishes the anguish of a long and torturing infliction on behalf of the patient. The maintenance of his own self-possession will make him master of the situation, and assure a neat, artistic finish to his task, with no unnecessary division of tissues, no mistaking of locations, and generally with no betrayals of doubt and hesitation or awkward and aimless manipulations, such as mark the attempts of the tyro and the novice.

The confidence and facility with which each move is accomplished will not fail to impress favorably those who are spectators of the operation, and to react favorably and profitably for the operator. The operative function of veterinary surgery requires, on the part of the man who practices it, a certain corporeal vigor, associated with sufficient agility to be able effectually to overcome the resistance of animals under torture, and counteract the efforts and avoid the injuries they are always so prompt and often so dexterous in inflicting upon those who are causing them pain. The veterinary surgeon must be cool-blooded and patient, never losing his presence of mind while directing the manipulations, often so difficult and dangerous, which are necessitated at his hands, especially when the large domestic animals are under treatment. He must then—always, in fact—be prepared for all difficulties and eventualities that may arise, whether before, during, or after an operation, and he must inspire confidence in his assistants by using full precautions for their safety and for his own, in his defensive dispositions against the dangers to which they are exposed.

It is especially as therapeutic measures that operations are necessitated in the treatment of diseases and

injuries, as, for example, in the case of the removal or extirpation of diseased or altered parts whose morbid action injuriously affects the general health or prevents recovery from a pre-existing disease. This class of operations includes the opening of abscesses, the extirpation of gangrenous parts, or of necrosed or carious bone; or again, for the modification of the nature of a traumatic lesion in order to stimulate cicatrization, as in the opening of a fistulous tract, or the resection of an ulcerated surface, or when the tissues are to be relieved from the presence of a foreign body or the abnormal product of a natural function, as in case of esophagotomy, or of calculus of the bladder, or of the salivary ducts. Operations have also their prophylactic uses, especially in the various forms of inoculation and vaccination as anticipatory and preventive of infectious diseases. They find their further obvious indications, again, in remedying physical lesions when applied to fractures, dislocations, deformities, and the endless list of accidental injuries, wounds, and hurts of every kind and degrees. And finally, they have their justifiable use in mutilating the larger domestic animals designed for purposes of labor as beasts of burden or draft in improving their adaptability by castration or spaying, or, as it is commonly termed, "altering."

Thus the general purpose of an operation is to palliate, cure, or assist in the recovery of surgical diseases; to prevent disease, and to so modify the condition of the domesticated animals as to enhance their usefulness and value to their human owners.

To accomplish these ends we do not depend upon surgery alone, but also employ such agents as setons, sutures and bandages, drainage tubes, and antiseptics. To the mechanical appliances we need not devote any time, as all veterinarians are familiar with their use, but

the use of antiseptics and biological products differs greatly in the practice of veterinarians.

The use of medical agencies in the treatment of wounds depends upon the character of the wound and the nature of the bacteria that may have or that have gained access to the wound. A solution of continuity may be of almost any shape or form imaginable and from a clean incision to a ragged, dirty, lacerated wound, located in any region, tissue, or organ of any part of the organism.

These variations make it imperative on the part of the operator or veterinarian to exercise wide judgment in connection with his theoretical training, since various complications (such as exposed tendons, open joints, a puncture into the abdomen or thoracic cavity) require treatment peculiar to the extent and character of the lesion. The wound, being made, the operator recalls the ways by which the pathogenic bacteria may enter into it, —by the air, by the hands and clothing of the operator,— or by means of foreign bodies (stone, sand, nails, wood splinters, pieces of earthenware) which enter the wound simultaneously with the wounding. Then the resting place of the patient, either during the operation or afterwards, may be such as to infect the wound, or infection may come by means of the instruments and bandaging material, or from the region surrounding the wound (skin, hair, nails, hoof).

If an operator makes a fresh wound, he first considers by what mode and by what means he can prevent the infection of the wound, and if the wound has been previously made, he considers how he is to remove an infection already existing in it.

Therefore we have two different subjects to consider, according to whether the wound is already infected or not. If our aim is to protect a wound against infection we speak of aseptic treatment of wounds, while disin-

fecting or antiseptic treatment of wounds is referred to when an already infected wound has to be liberated from the infection—that is, disinfected or made aseptic.

We therefore should not be surprised that the remedies used for the prevention of wound infection are entirely different from those used for the removal of an infection already present; hence the remedies used in the treatment of wounds are divided into two groups: first, bandaging material; and second, disinfectants. Bandage materials should possess certain qualities to obtain the desired effect. First, they must be porous so as to absorb the discharges of the wound; second, they must be free from infectious germs, so as not to be a source of infection to the wound; third, they must be soft, elastic, and flexible, so as not to cause pressure on the wound, and must adapt themselves to the corresponding parts of the body without forming any gaps. If there are no infectious germs already present in the wound their introduction is most liable to take place from the outside. To avoid this, the bandaging material should be impregnated with some reliable disinfectant so as not to permit of infections gaining access to the open surface of the wound. By this means the germs that may gain access into the bandage material are destroyed or find that the discharges absorbed by the bandages are unfit as a nutritive medium for their development.

Disinfection means nothing else than the removal or destruction of the germs or infection. Disinfection of wounds, or of an instrument, or of the operating field, the air, hands, and clothing, ligature and drainage tubes, stable and resting places, means making innocuous the infectious germs located in the respective media that may bring them in contact with the wound. Most disinfectants act simultaneously in two or more ways, and we may divide the methods into three groups: First,

physical disinfection agents; second, chemical disinfection agents; and third, biological disinfection agents.

Among the physical agents we class all surgical instruments by the aid of which we can remove infected material in a purely mechanical way, such as the knife, scissors, or sharp spoon; also the high degree of heat in the form of the firing iron or thermocautery, and finally the withdrawal of moisture—namely, exsiccation and permanent irrigation.

The chemical agents hostile to the development of micro-organisms are principally mercuric chlorid, iodin, iodoform, iodol and iodin trichlorid, carbolic acid, creolin, salicylic acid, boric acid, chlorid of zinc, camphor, tar, turpentine, bismuth subnitrate, salol, and many other similar mediums and prepared preparations.

The biological products or bacterins help in disinfecting a wound by assisting the animal organism in destroying the infectious bacteria. This once accomplished, the tissues proceed to make repair, and in the course of due time, if new formations foreign to the part do not develop, the desired effect will be accomplished.

PRACTICAL SURGICAL CLEANLINESS

By MART R. STEFFEN, V.S., M.D.C., Brillion, Wisconsin

There is now an apparent tendency among surgeons, both human and veterinary, leading in the direction of a sane, practical balance in the conception of surgical cleanliness.

As with many other good things, so also with our ideas of sepsis and asepsis, extremes have been developed and accepted which we are now endeavoring to adjust. The treatment of fresh, accidental wounds seems to afford the best field for the application of new and improved thought along these lines, and the main point which nearly all writers attempt to carry in recent articles is, that *the assumption of microbian contamination in all wounds of an accidental nature* is erroneous.[1] Almost without exception the various contributors to medical and surgical papers dealing with this subject condemn the doctrine which has, until recently, been generally accepted and which held that *all* accidental wounds were to be treated as infected wounds. The result is that the treatment of wounds is undergoing a change, especially as regards the excessive washing and irrigating with antiseptic solutions. It is pointed out that such washing and irrigating is detrimental for two chief reasons; one, that it always devitalizes the tissues; the other, that it mechanically removes the bacteriolytic exudate that appears almost instantly on all wounds—nature's means of controlling whatever infection *might* be present. Dr.

[1]See also the chapter on open joints in my book, *Special Veterinary Therapy*, p. 19.

W. W. Grant, speaking of handling wounds that accompany fractures, says:

"At the present time it is not considered advisable to enlarge the wound or to irrigate, unless dirt or some infective material is in the wound. The old maxim, which considered every compound fracture as infected, is not sound nor borne out in practice."

In an article on wound and skin sterilization Dr. Lile says, in the *International Journal of Surgery:* "The plan adopted by the writer in all cut, bruised or lacerated wounds is never to wash, but before allowing anything to come in contact with the wound to swab it off with the five-per-cent tincture of iodin and cover with sterile gauze."

While the foregoing remarks are mainly in reference to human surgery, veterinary surgeons can afford to pay some attention to them. Excessive washing of wounds is the rule in veterinary practice, and no doubt works as adversely in our patients as it does in human beings. One hindrance to an ideal handling of wounds in our patients, especially equine patients, is the tendency toward exuberant granulations, or "proud flesh," as it is commonly called. It is my opinion, formed through practical experience, that this tendency is aggravated by much washing or other applications, such as irrigating with antiseptic solutions.

Referring to the sterilization of the unbroken skin for surgical incision, Dr. Lile says in the same paper, "In operating where the skin is unbroken the surface is first painted with gasolin or benzin, then dried with sterile gauze or a towel, and painted with the standard iodin solution, and the patient is ready." He also remarks that to Grossich is due the credit of bringing iodin disinfection to its present scientific basis and that he has "called attention to the fact that thorough sterilization

could be obtained only when the iodin solution was applied to a dry surface.''

From personal experience with this method of sterilizing the skin previous to surgical operations I can say that it is equally safe and sufficient in veterinary practice if the hair is first shaved off.

VULNERARIES[1]

By DOUGLAS H. STEWART, M.D., New York

The days before antisepsis, treatment of wounds, so far as dressing was concerned, made its demands upon the patient's own healing powers, which were to be aided by vulneraries. Then came the Pasteur-Lister methods, which aided the patient not at all, considered the wound-healing application of small account, but did interpose a shield between the patient and extraneous infection. About the year 1895 there appeared the experimental work of some German surgeons, who claimed that the use of antiseptics in infected wounds was of no benefit. For centuries there had been in use a plant known as bruisewort. Modern men were experimenting with placental membranes. Now the consensus of opinion is that wounds require both the shield of the dressing and the reinforcement of the patient's bactericidal products.

The value of the vulnerary begins where the surgeon leaves off, and bruisewort, or comfrey, had been more or less in use for ages. Nor can any one who has had experience with this plant be persuaded that it does not possess tissue-building powers. Neither is it strange that those powers should be sought for in embryotic tissues, because the active principle of placental membranes as well as of Symphytum officinale (that is, comfrey) is allantoin. German literature treats approvingly of that plant as a wound-healer, and personal experiment confirms the good results claimed therein. The Americans claim that comfrey will cause the disappearance of sar-

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[1]Reprinted from *The American Journal of Clinical Medicine.*

coma. I do not believe, because I do not know; but, not knowing I have not the recklessness to say, "Impossible."

Nature's usual first step in healing an incised wound is to discharge a thin serous fluid. Attempts at aiding this first step are made by using an "osmotic pump"; that is, by applying some substance of high specific gravity in which an antiseptic is dissolved, and anticipating that germs carried out of the tissues will be killed as are those of external origin. Hence, glycerin and its combinations were used, and later sodium chlorid was similarly employed. This salt regulates osmosis and imitates some of the functions of blood serum. Other sodium or potassium salts were mixed with the sodium chlorid until finally Wright, of England, mentioned the advantages of the citrate.

Wright's solution has been widely and successfully used; but it is really a wound-healer, pure and simple, and is devoid of any germicidal value. It compares well with allantoin, and, in view of the raging European war, is much more accessible. It does seem as if the vulnerary had come into its own again, after all; at the same time, the lessons learned from the wave of antisepsis are many and important.

Suppose one were to secure a vulnerary which was at the same time a germicide, yet free from the drawbacks called irritation. Suppose a mixture existed which was sedative to tissues and attacked neither skin nor instrument. Suppose this preparation would take care of vaginal or dormal injuries so far as redness, heat, pain, swelling, and discharge were concerned. Suppose a surgeon could employ it equally well to treat vaginal gonorrhea or a septic or an aseptic wound, or use it on his own face after shaving. Then it might well be called the surgeon's own powder, especially if it were odorless.

There is such a combination, which, when it is brought

in contact with an animal fluid or discharge, at once breaks up into Wright's solution, plus aluminum acetate, plus insoluble white lead; and its results are exactly what any one would imagine they would be when backed up by the most powerful osmotic pump known; namely, cane sugar, which compares with glycerin as 1,600 to 1,250 or less.

The experimentation which led up to this combination of wound-healer and protector would make many papers such as this one. There seems to be some difficulty in making the preparation; however, the power machines experience no trouble. Consequently it would appear to be a question of trituration. Its formula for general use should be as follows:

Sublimate	grs. 2
Sodium citrate	grs. 40
Sodium chlorid	grs. 240
Alum	grs. 180
Lead acetate	grs. 360
Sugar, enough to make	ozs. 16

Since writing the above, I have heard that some are using this compound either before or after the usual hand-cleansing procedure, as it keeps the operator's hands soft and pliable. Personally, after returning home from an operation I make it a habit to take a teaspoonful of the powder in my hands, rub it in thoroughly (it gets wet by rubbing), leave it on for five minutes, and then wash it off with cool water.

PRACTICAL WOUND APPLICATIONS

By A. W. WALDRON, JR., D.V.S., Tullahoma, Tennessee

While aseptic surgery is ideal it is far beyond the attainment of the country practitioner in a location such as this, where the farmers clean their stables but once a year.

Undeniably, all antiseptics irritate wounds and retard healing; but their use is imperative, and furthermore the dressing must be as simple as possible to apply, and should require but little of the attendant's time. For as a rule elaborate directions will not be followed.

Each year I use less bichlorid and more tincture of iodin, which is I think the best application for the great majority of wounds, both surgical and accidental. Applied once a day with a swab or syringe, and later every second or third day, its effects are most satisfactory. The pain its application occasions is ephemeral. By its use we obtain most of the benefits of iodoform, without the offensive odor and at far less expense than we could use the powder. An application of 100 parts fish oil, 50 parts oil of tar, and 1 part carbolic acid, or the common "black oil," a petroleum product, will protect the wound from flies. Either one is both inexpensive and effective. Paint around the wound with one of the above three times a day.

Iodin is most excellent for the general purposes of the country practitioner, whose methods must almost always be more or less rough and ready. It is a useful application to the points of sutures, for sterilizing a line of incision, and as an application to many forms of contused

as well as lacerated, punctured, and incised wounds. This refers alike to wounds in muscular, tendinous, and osseous structures. Under this treatment large and deep wounds will remain practically dry if made under reasonably good aseptic precautions.

For wounds in the oral, abdominal and the other natural cavities, hydrogen dioxid is my favorite antiseptic, either full strength or diluted and used *ad libitum*.

For surface wounds, and where it is desirable to produce a dry scab as quickly as possible, as in "broken knees," there is nothing equal, I believe, to tannoform; for persistent urachus this is also very valuable, often relieving the condition in forty-eight hours, if applied every three hours to the umbilicus in sufficient quantity to cover the area rather thickly.

For surface wounds where the cost of the dressing is more of an object, an absorbent mildly antiseptic and astringent, dusting powder often answers well. All of the above dressings are most efficiently and economically applied by means of the small insect-powder blowers to be obtained from druggists.

Pulverized copper sulphate quickly destroys the excessive quantities of granulation tissue so frequently found in old and neglected wounds.

As a protective dressing to open wounds that are suppurating but little in seasons of the year when flies are bothersome, the following prescription does very well. It is particularly applicable to wire cuts and other lacerated wounds.

	oz.
Phenol	1
Gum camphor	5
Resin	1
Methylated spirits	15

M. Sig. Paint on wounds three or four times a day.

ABDOMINAL WOUNDS OF ANIMALS[1]

By J. V. LACROIX, D.V.S., Kansas City

Under abdominal wounds of animals may be included a wide range of conditions wherein divers factors are to be reckoned with. In this brief treatise we shall consider the subject in a general way only, mentioning specific instances in the way of case reports merely for emphasis.

Our domestic animals are all, because of the manner in which they are kept, subject to injuries of the abdomen. In a general way the horse and mule are more frequently affected than are the other animals. The fact that horses, used as they are in all kinds of service, exposed to various injuries in the way of runaway accidents, kicking one another when shod with calked shoes; together with the anatomical construction of the abdominal wall, accounts for their being frequently injured. The abdominal wall of the horse is more tense than is that of other animals, and being very agile and quite likely to struggle whenever any vulnerable object contacts the abdomen, they are often seriously injured. The ox, under the same conditions, would suffer little or no harm.

Cattle receive abdominal wounds rather infrequently. They are subjected to contusions probably more frequently than to any other mode of injury. Having thick skin and a rather loose and pliable abdominal wall, punctures and lacerations are of comparative infrequency.

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[1]Read at the 50th annual meeting of the American Veterinary Medical Association.

Sheep have loose abdominal walls, and in addition the skin is protected by wool. Abdominal fat is usually quite abundant, and as sheep are not inclined to greatly resist confinement in any position, they seldom suffer from injuries of the abdominal walls.

Neither are swine frequently the victims of abdominal wounds, though brood sows with large, pendent abdomens receive lacerations of the mammary glands occasionally, and various complications may ensue. This is the most frequent form of injury among these animals. Swine may wound one another in combat, or receive wounds from dogs or wolves, but this is not of frequent occurrence. Having more or less fat underlying the skin, they may receive extensive and deep wounds without making eventration imminent or necessarily a sequel, the result of a post traumatic necrosis of tissue.

Abdominal wounds are classified variously by different authorities. We shall for convenience here consider them under four classifications, as follows:

1. Contusions with subsurface solution.
2. Lacerations without eventration.
3. Wounds with eventration and without visceral perforation.
4. Penetrant wounds with visceral perforation.

Contusions with Subsurface Solution of Continuity

Contusions with subsurface maceration of tissue frequently occur in horses and mules. This type of injury is occasioned by any heavy blow that is sufficiently forceful to sever any one of the several layers comprising the abdominal parietes. Contusions are so directed as to displace relations of the various layers of the abdominal wall, by rupturing tissue, allow of considerable extravasation of blood and serum. Such injuries are accomplished by falls or kicks, or by, the animal being crowded against door jambs or gate posts, or bunted by cow's horns.

Manifestation of such injuries may be evident within a few hours after they occur, or they may pass unnoticed until much subsurface extravasation or discharge of fluids has taken place. In some cases, only a small amount of blood escapes into the tissues, little swelling occurs at first, and not until infection has taken place is there marked inconvenience manifested by the subject. Abscesses occurring in this manner often contain large quantities of pus, and it is a noticeable fact that such conditions may persist for weeks at a time without perforation of the abdominal wall from necrosis.

To differentiate between abscess of the abdominal wall where there exists a large cavity filled with fluctuating detritus, and hernia, is not easy in certain cases. In vicious horses, where the condition is painful, little is to be learned by palpation while the subject is standing. By casting such animals and placing them in such a position that the swelling is located uppermost, one can exclude hernia by absence of perforation of the underlying structures, and failure at reduction of the mass. Finally, by using an exploratory trocar or needle, hernia can be excluded.

Where such abscesses involve one or more floating ribs, necrosis is likely to result in perforation of the abdominal wall, and being situated nearer the superior part of the abdomen, swelling is not so extensive and it is more defined.

Treatment of such cases consists in evacuation of all pus and the removal of shreds of necrotic tissue. Such abscesses should be so opened that perfect drainage may take place and little after-care be necessary.

An extreme case of this kind was treated by the writer in 1906. The subject was a gelding weighing eleven hundred pounds. He was very vicious, and the owner had given him little or no attention. Not until the swelling

had gradually increased for about six weeks was any attention given the case. Location of the enlargement was in the left flank, and it extended from the umbilicus to near the anterior iliac tuberosity. The fluctuating center was about twelve inches in diameter. It was not possible to determine the exact nature of the condition without casting the animal. After properly confining the subject, diagnosis was not difficult. The abscess was drained of a large quantity of pus and the cavity irrigated with a weak antiseptic solution. The subject was allowed exercise, but in about a week it became necessary to enlarge the opening made for drainage. The animal being hard to handle, no further treatment was given him, and complete recovery resulted in about a month.

Traumatisms immediately resulting in hernia, with more or less subsurface laceration of tissue, are met with frequently in all animals. Contusions produced by means of blunt objects often result in hernia because the skin is freely movable, and quite capable of withstanding injuries which do violence to the underlying tissues. Subcutaneous rents result in hernia where a sufficient opening in the abdominal wall is produced. Strangulation of intestine may occur, and unless cared for, results fatally. Strangulation usually occurs where the injuries involve the region of the groin. Non-strangulated herniæ are often found involving the floor of the abdomen anterior to the inguinal region.

No great difficulty is experienced in making a diagnosis of such cases, as they occur in connection with some injury and the skin usually bears evidence of violence, even though it be left intact. By rectal examination those parts of the abdominal wall that are within reach may be palpated and the nature of the swelling determined. Where strangulated hernia exists, diagnosis is not so easily made as in cases of non-strangulated hernia.

Treatment is imperative in cases of strangulated hernia and consists in confinement and anesthetization of the subject. The skin over the swelling is shaved and cleansed with soap and water, dried, and painted with tincture of iodin. A free incision is made, exposing the strangulated loop of intestine and the ragged edges of the subcutaneous wound. Reposition is effected by manipulation, after having drained a quantity of fluid with a small trocar. If little fluid is contained, it may be necessary to enlarge the opening slightly. After reducing the hernia, approximation of the wound margins is effected by means of sutures.

In a case of strangulated hernia occurring in a twelve-hundred pound mule, the animal had kicked over a partition and become impaled upon an upright timber. In his struggles a sufficient amount of tissue had been torn and badly mutilated to allow a hernia of the floating colon. Separation of muscular layers had taken place to an extent sufficient to permit of the incarceration of about twenty inches of intestine.

The writer was called about four hours after the accident occurred. At that time there existed in the left flank just anterior to and below the anterior iliac spine an enlargement ten or twelve inches in diameter, which was edematous in its periphery. Manipulation of the mass caused pain to the subject. By rectal examination it was possible to outline the irregular borders of this abdominal rent. The animal was very restless, and it was decided that immediate surgical intervention was the only recourse.

With assistance, the subject was cast, and anesthetized, the field prepared, and by means of a free incision the strangulated loop of bowel was exposed and replaced. The wound was prepared and the various tissue layers were sutured separately. The mule was allowed the free-

dom of a small blue-grass pasture, and beyond some suppuration which later necessitated drainage, a complete and uneventful recovery resulted.

Laceration Without Eventration

Laceration of some part of the abdominal wall without eventration is of common occurrence and is caused in numerous ways. Because of the fact that fibres of the several muscular layers of the abdominal wall are disposed in various directions, large wounds occur without complete perforation. This is particularly true when the offending implement is not possessed of a keen edge or a sharp point. Horses are kicked by others that are wearing sharp calked shoes, receiving extensive lacerations, but it is unusual for the victims of this mode of injury to suffer eventration at the time of accident. In jumping over and upon fences, lacerations of the abdominal wall occur; but unless the animal strikes an upright body capable of penetrating the abdomen, extensive lacerations usually take place without immediate eventration.

Lacerations of the abdominal wall are characterized by visible solution of continuity, fragmentary protrusion of margins, and more or less hemorrhage. Because of the facility with which separation of tissue layers takes place, sacculations are to be found under the margins of the wound; these extend in various directions, and where gravitation or pressure does not interfere, they are filled with blood.

Where such wounds are not too deep, and conditions make impracticable other and more elaborate treatment, they may be cared for by trimming away all macerated tissue, controlling the hemorrhage, and further dressing them as open wounds.

Where such lacerations are deep and involve so much

tissue that eventration threatens, coaptation of the wound margins in some manner is necessary.

In the handling of such cases in large animals, the first problem which confronts the operator is that of restraint. Certain it is that the subject must be confined, and unless the wound is high up on the side, a recumbent position is necessary. As a precautionary measure it is well to apply a temporary bandage to protect and support the parts until the animal is placed in readiness. If much suturing is to be done, complete anesthesia is imperative. Local anesthesia would suffice were it not that the subject usually resists confinement even more than the pain inflicted by the process of suturing.

Since the treatment of such wounds constitutes emergency surgery, there is no time for the preparation of the subject, and one must count on an occasional loss from anesthesia, delirium, or shock.

Careful attention must be given to cleansing the skin bordering the wound. A liberal area should be shaved, all macerated tissue removed, and the wound thoroughly cleansed by mopping with gauze or cotton moistened with a mild antiseptic solution, or with sterile water. After hemorrhage has been controlled, all parts should be moistened with tincture of iodin. Particularly is this essential if the wound has taken place several hours prior to its being treated, or if it has contained much dirt or filth.

Approximation of the wound margins, with the exception of the skin, may be brought about by means of continuous sutures of chromic gut. Each of the several layers of tissue comprising the abdominal wall should be sutured separately, then the skin should be sutured with a heavy material either of silk or linen. Mattress sutures

serve very well. Reinforcing sutures in the skin and subcutem are useful in some cases. This method of suturing is applicable in all cases where coaptation is attempted. Some suppuration occurs in the majority of cases, and drainage should be provided for by means of a tube or by inserting at some pendent part of the wound a suture that is readily removed. After-care consists in keeping the parts clean and restricting exercise. Plenty of time should be allowed that complete repair may take place, else hernia is likely to occur even three or four months after the wound has completely healed. The parts may be supported by means of heavy bandage material during the process of treatment, but it is doubtful if this is of real service if the wound has been properly sutured. In large animals wounds so treated are completely united within thirty days unless swelling persists and considerable necrosis results.

A lacerated wound of the abdominal wall in a mule, the result of a kick with a sharp calked shoe, was treated at the Kansas City Veterinary College in January, 1911. The injury was located in the right lower abdominal region about eight inches from the median line and twelve inches anterior to the pubic brim. All of the structures except the peritoneum were lacerated. The wound extended almost at a right angle from the spinal axis, and was about five inches in length. Much dirt and filth had been carried into the depths of the wound, and there was extensive maceration of tissue.

The animal was placed upon an operating table and the wound treated as just outlined. Union of the parts had taken place in about three weeks, and the patient was then dismissed from the hospital. She was put to heavy work at a grading camp, and a hernia resulted. However, this did not interfere with her usefulness, but

was the direct result of an insufficient length of time being allowed for complete repair to have taken place before putting the animal in service.

Wounds With Eventration and Without Visceral Perforation

Wounds with eventration and without visceral perforation occur in all animals, the result of direct injuries of various kinds. The agent inflicting such injuries is not sharp enough to perforate viscera immediately upon coming in contact with them, even though driven with great force. This type of wound occurs in horses that are gored by bovines, or become impaled upon upright posts or implements of various kinds. The writer has observed fatal eventration in the horse where a rent at least eight inches in length was inflicted by a Jersey cow's horn. Where much of the intestine protrudes it is likely to become injured beyond repair, unless it is given immediate protection in some manner until reposition is effected. Even though successful reposition of the intestine is effected, there is danger of peritonitis, and considerable shock always attends injuries of this kind. Where such wounds involve the floor of the abdomen there is likelihood of hernia resulting unless it is possible to securely approximate the wound margins.

Treatment consists first, in protection of the exposed viscera and appropriate confinement of the subject. After thoroughly cleansing the visceral organs, reposition is attempted. In the large animals, if there is much struggling or straining, complete narcosis is needed. Reinforcement and protection of the wound with dressings and bandages is helpful in small animals, and may

be of some advantage in the large animals. However, where such wounds are kept covered they remain moist, and are prone to suppurate unless frequently redressed.

Penetrant Wounds With Visceral Perforations

Visceral perforation occurs occasionally in any of the domestic animals and is the result of gunshot wounds, thrusts with sharp implements of any sort, or where animals become impaled upon sharp projecting bodies. In the smaller animals tooth wounds sometimes penetrate the intestine.

Where the perforation is large in animals that resist manipulation of the peritoneum, it is possible to close the intestinal wound by means of bowel anastomosis or by approximation of its margins with sutures. Spontaneous marginal adhesion of serous membranes with the production of fecal fistulæ is not of uncommon occurrence.

Where small puncture wounds involve the bowel in numerous places, allowing the escape of intestinal contents into the peritoneal cavity, there is no effectual means of intervention except such as occasions laparotomy; therefore the repair of this form of injury is often impracticable.

OPEN JOINTS

By J. N. Frost, D.V.M., Ithaca, N. Y.

The literature in regard to suppurative arthritis seems to be a minus quantity so far as veterinary surgery is concerned, and the case reports are few. As one medical work states, "Our knowledge of joint disease is so imperfect that no opportunity should be lost by which clinical data may be added."

Causes.—The causes of open joints are kick wounds, nail punctures, and the like, which not only open the joint capsule but are liable to carry infection to the joint cavity, where synovia serves as a favorable medium for the development of the bacteria. Another cause is the extension of necrosis from neighboring areas of infection, such as tendon sheaths or bursæ. Likewise, it may result by the process of metastasis from some distant suppurating foci.

The severity of articular wounds is not due to the lesions produced, but to the inoculation of the wound with bacteria. When pyogenic organisms gain entrance to a joint cavity they lead to inflammation of all the structures of the joint, followed by suppuration, and, unless overcome, to the destruction of the joint cartilage and its discharge in the form of pus, leaving the ends of the bones bare and rough. Naturally, this leads, in those joints where the movement is limited, to ankylosis or stiffness of the joint.

Symptoms.—If the wound of the joint is small, and made by a clean instrument, the only symptom may be the discharge of synovial fluid. In most cases there will

be, however, some infection which results in signs of irritation, such as swelling of the joint, increased synovial fluid, or tenderness on palpation. If the infection is severe there will be edema, fever as high as 104 to 105 degrees, with pulse and respiration increased. The patient holds the swollen, painful articulation in a position to relieve the pain as much as possible, touching only the toe to the floor. Frequent convulsive movements are made with the leg, indicating pain in the part. The tissues surrounding the joint are inflamed and swollen, and there is a discharge of synovia from the wound, which at first is a slippery, transparent, straw-colored liquid. Synovia may be recognized by its tenacity if the finger which touches the fluid is slowly withdrawn. This is a sure sign that the fluid has come from a synovial bursa, or, in other words, that it contains mucin.

As inflammation of the joint advances, the synovia is discharged in thick, heavy clots. After the synovial membrane becomes infected, its secretion is greatly augmented, and the discharge is a thick yellow mixture of pus and synovia, which is thrown off in large quantities.

The loss of flesh is exceedingly rapid, even though the appetite remains good. Due to long periods of decubitus, sore and infected areas develop on the skin over the external angle of the ilium, the shoulder, and the supra-orbital process of the head.

The differential diagnosis between a suppurative arthritis and suppurating tendon sheath is not always easy, as the discharge from each has the same general appearance and around most of the joints there are tendon sheaths which may become opened more readily than the joint. There is usually a difference in the degree of lameness. The animal with open tendon sheath does not ordinarily show as great pain upon movement or

upon bearing weight on the part as does the animal with open joint.

By probing we can usually make our diagnosis positive. We are told by many that probing should not be resorted to, and this no doubt is true if it cannot be done in an aseptic manner. We fail to see, however, why there should be danger if we are careful to disinfect the wound and then use a thoroughly sterilized probe. After probing we are in a position to give a more accurate prognosis and treatment.

Treatment.—The treatment of suppurative arthritis is highly unsatisfactory, necessarily of long duration, and in a great percentage of cases unsuccessful. The death rate has resulted in the trial of drugs, with poultices, blisters, continual irrigation with weak antiseptic solutions, ointments of camphor, alum, calomel, and corrosive sublimate.

In the treatment of open joints, they may be divided into two groups:

1. Open joints, such as the stifle, shoulder, or elbow, where ankylosis cannot occur, or, occurring, would destroy the usefulness of the animal.
2. Open joints which, if ankylosed, would not seriously impair the value of the animal, such as the smaller tarsal joints of the corono-pedal joint.

The first question to be decided when a joint is involved in acute suppuration is whether an attempt should be made to prevent ankylosis or whether the process should be favored.

Taking the first group, which comprises the more important joints and in which ankylosis would be disastrous to the usefulness of the animal, we find it impossible, or at least impracticable in the larger animals, to bandage these parts. If the joint is not infected by the object causing the injury, it is almost certain to become infected by exposure. In treating these cases

we must prevent too great an infection, which causes an inflammation and destruction of the capsule and cartilage, and thereby results in ankylosis. We must also be careful that our antiseptics are not so strong as to cause some irritation to the joint capsule and cartilage, producing inflammation as well as increasing the chance for infection and in so doing hasten the destruction of the part.

It is a known fact that most of our antiseptics cause irritation to the tissues even in a strength which is too mild to harm bacteria. Our antiseptic then must be one that not only prevents the growth of bacteria but also that does not produce irritation of the tissues.

We have found pure glycerin to be an agent which produces no visible irritation of the tissues, and we have also found that bacteria fail to multiply upon it. According to Rideal on *Disinfection and Preservation of Food,* bacteria and insects are killed by undiluted glycerin, since, having a very low diffusive power, it causes death by desiccation. Spores with thicker envelopes resist it indefinitely, and on dilution of the glycerin begin to grow immediately. Cultures made in the laboratory of Streptococcus and Staphylococcus, and mixed cultures from cases of fistulous withers, fail to make any growth on glycerin. The injection, under aseptic conditions, of pure warmed glycerin into the hock or stifle joint of a horse causes the animal no distress, and is followed by no increased heat in the part, no pain upon pressure, and no change in the gait of the animal.

We find also that when we inject, under aseptic conditions, one part of Lugol's solution to four parts of glycerin, or in other words, twenty-per-cent Lugol's solution in glycerin, it fails likewise to cause irritation.

In order to determine the amount of irritation produced by glycerin, we injected two ounces, slightly warm, into the joint capsule of a horse. Twenty-two hours later the animal was killed. It had shown no signs of irritation, and the capsule of the joint failed to show any congestion. Another animal, treated in the same way, was killed forty-eight hours after injection, and failed to show any symptoms, and the joint capsule remained normal. Two other animals were injected in the stifle joint in the same manner. One was killed on the third day; the other, at the end of two weeks. Neither showed any ill effects from the injection, and the joint capsules remained normal. In all, fourteen horses were injected, and none showed any signs of a disturbance in the joint.

Later, injections of twenty-per-cent Lugol's solution in glycerin were made in the same manner, and the animals killed at intervals of four, eighteen, and forty-eight hours, and three weeks. In all, we were unable to see that any irritation had been produced.

The treatment recommended by us for open joints, in which we wish to prevent ankylosis, is, first, to shave all hair from the area surrounding the wound, following with a thorough cleansing of the skin and disinfection of the wound, and then to inject a twenty-per-cent Lugol's solution in glycerin into the wound. This should be repeated two or three times a day, each time enough of the solution being injected to fill the joint capsule, thereby securing the flushing effect. As this solution does not cause irritation to the tissue and yet is a strong antiseptic, it serves to shorten the period of congestion and inflammation and to overcome the infection without causing a destruction of the secreting membrane until the external wound has had time to heal. The injection of this solution seems to retard the excessive secretion of

synovia. The larger the joint capsule and the smaller the external wound, the longer our antiseptic will remain in contact with the inflamed tissues as the glycerin, being thick, does not flow through a small opening.

In treating the second group of open joints, those joints in which ankylosis does not impair materially the value of the animal, we believe the treatment should be much the same in the beginning as for the first group. If we find the secreting membranes are highly infected and cartilages are becoming eroded, ankylosis is bound to occur, and we should direct our treatment toward hastening the process.

In this group we can use the bandage and antiseptic pack to good advantage, as all of these joints may be readily bandaged. The application of a 1/100 corrosive sublimate or other antiseptic pack should prevent further infection to the part. In making the pack, we have found it advisable to use gauze in place of cotton, as the gauze allows the secretion to pass through and thus drain away, while the cotton has a tendency to dam back the secretions and hold them in contact with the wound, thus preventing the flushing action produced by the secretion of synovia. The free discharge of synovia acts as a flushing agent and thus carries out infection and pus from the joint cavity. The proper application of the pack and bandage constitutes the first principle in the treatment of inflammation—namely, rest to the part—by preventing or lessening the motion of the joint. Motion results in irritation to the tissues and promotes infection. We may render the joint immovable by the use of splints, shoes with a brace, or tar bandages and heavy packs. That this greatly lessens the infection and pain is shown by the unusual amount of weight the animal will bear on the part.

By making a free opening into the joint, we may be able to curette away the joint cartilage and thus hasten the process of ankylosis. Then, too, by increasing the size of the opening into the joint, we have a better opportunity to disinfect thoroughly the joint cavity, overcome the infection, and thus prevent fatal sepsis. Abscesses in the periarticular tissue should be opened wherever they occur and their cavities thoroughly drained and disinfected.

For the purpose of disinfection we have found long narrow strips of gauze saturated in tincture of iodin to be of great benefit. The iodin also serves as more or less of an irritant, and causes a destruction of the secreting membranes and joint cartilage which must take place before we may hope for recovery.

In the human being and in the smaller animals there is another operation which may be resorted to—amputation. When the infected area is great and there is danger of death from septicemia, the removal of the distal portion of the member allows of thorough disinfection of the joint, as well as the removal of the infected area which is producing the sepsis.

We do not favor the use of slings in disease of the articulations, believing that the animal, if worth treating, is able to get up and down readily if given a box stall with sufficient room. Certainly a horse, if given a proper amount of dry bedding to prevent decubical gangrene, rests more comfortably in a large stall than in a stiff pair of slings. Another point which is often ignored is the removal of the shoes from a horse which is spending much of its time in a recumbent position. The bruising of the pectoral region from the front shoes, and the resulting infection, may be sufficient to overcome an animal that is fighting to withstand the attack of septicemia resulting from suppurative arthritis.

OPEN JOINTS

By MART R. STEFFENS, V.S., M.D.C.

This subject will be considered in two parts—open joints of recent origin in fresh wounds, and those of a chronic or subacute and infected character.

Fresh Wounds Lacerating a Capsular Ligament

It frequently happens as the result of accidents that an articulation is involved in the trauma. While all accidental wounds in veterinary patients are to be considered surgically unclean, it is well not to carry this theory too far. Unless much extraneous matter, such as hair, chaff, etc., has entered directly into the articulation do not allow antiseptic solutions to penetrate to the synovial surfaces when you clean up such a wound.

Swab the surroundings as clean as possible with a cotton swab, but do not allow any of the solution to reach the joint. Nothing seems to irritate a synovial joint more than water.

After the surrounding parts are thoroughly swabbed and dried with clean, dry cotton, the wound cavity is completely filled with chemically pure powdered sodium bicarbonate, some of which is even gently pressed so as to enter the synovial cavity. It is important that enough be used. A thin layer of cotton is now made to cover the lesion and is retained either with collodion or bandages.

This dressing is allowed to remain for twenty-four hours. At the end of that time it is removed and the wound carefully inspected for synovia. No instru-

mentation is permissible; the inspection is confined to looking into the wound for traces of synovia. If no synovia is to be seen the wound is treated along regular lines.

If synovia is present in the wound the treatment is repeated as on the first occasion and again left on for twenty-four hours. More than two such applications are seldom necessary, and unless the wound has been very large and is very severely infected, good, healthy granulations and no synovia are present after the first twenty-four or forty-eight hours.

Chronic, Infected, Purulent Joints

The treatment of these is radical. While it happens now and then that cases of this kind recover with dilatory methods of treatment, it is only by radical procedure that prompt and positive results can be obtained.

The various articulations of the equine present varying degrees of severity and obstinacy in this affection. The elbow joint stands at the head of the list of fatal terminations. I would class the coffin joint second. Next in order I would place the hock; last, the stifle.

The following method of treatment is always successful in cases in which the patient has not become greatly emaciated and still retains the greater part of his vitality and good spirits. It is successful in fifty per cent of the latter cases, but it is of no avail (nor is any other treatment) in cases where the patient is down and refuses to eat. Such cases rally occasionally for a temporary period, only to go down again later and die. If the surgeon will select for this treatment cases which are, while moderately grave, still in good general condition, or even fair, he can promise his client good results.

To carry out this treatment properly it is essential to cast the patient either on the ground or on the table. The following procedure is then adopted:

Thoroughly cleanse the region of the joint involved, shave and scrub. Irrigate the joint cavity for at least ten minutes with a solution of hydrargyrum chloridum corrosium (1 to 3,000) at body temperature. This must be done with the utmost antiseptic precaution and great delicacy. If the opening in the joint is in such a position that good drainage cannot be obtained, another opening is to be made surgically at the desired point.

Having thoroughly flushed the joint cavity with the solution, for which purpose a fountain syringe is best, it is now again flushed for a considerable time with sterile physiological saline solution at body temperature. These washings are to be discontinued only when the fluid comes out clear and free from pus, flakes, or detritus. It may take a half hour of continuous irrigation to accomplish this. When this has been accomplished the interior of the joint may be considered surgically clean and it is now injected with the following suspension:

Hydrar. Iod. Rub. . . . . ℥iv
Ol. Olivae Pura. . . . . ℥iv
M. Sig. Shake before using.

This is to be injected into the cavity slowly after plugging up all openings except the one through which it is to be introduced. The entire quantity is injected so as to be sure every portion of the interior comes in contact with the suspension. As soon as this is done the entire joint is swathed in clean cotton held in place by such bandages or retaining appliances as the surgeon's ingenuity may devise. This dressing is to remain in place for two weeks.

In nine out of ten cases a complete cure will have been effected when the dressing is removed at the end of this time. In rare cases it may be necessary to repeat the treatment. It is very important that the entire joint be heavily swathed in cotton which must be held snugly, yet not tightly, in place.

The patient must be kept as quiet as possible until the two weeks have elapsed, and during this time should receive a dram of hexamethylenamin in a pail of drinking water three times daily.

Hexamethylenamin is of much value in various forms of arthritis; it has been found that it is excreted by serous membranes and it has been demonstrated to be present in synovial cavities within an hour or two after administration. Its antiseptic action is due to formaldehyde, which is liberated during the process of elimination.

TETANUS FOLLOWING SURGICAL WOUNDS

By HENRY SMITH, V.H.S.

Up to the present time tetanus following operation has been put to the charge of the surgeon. The implication has been that he introduced the tetanus through suture, lotions, dressings, instruments, sponges, or from his own hands or those of his assistants—not a very comforting reflection for the surgeon. Why should this tetanus occur in spite of the utmost care on the part of the surgeon? I believe that the reason is explained by Sir David Semple's paper. An anaerobic area has been left—the *sine qua non* for the development of tetanus from tetanus spores. Sir David Semple has shown that the spores of tetanus are frequently present in the human intestine. He has shown that when tetanus spores are injected into a given area of a guinea pig, and quinin injected into a different area of the same guinea pig, tetanus bacilli are to be found in the anaerobic slough produced by the quinin and nowhere else, and that a control guinea pig which has similarly received an equal number of spores, but has not received any quinin, is not affected by tetanus. How do the spores reach the anaerobic area in this case? I can explain it only on the supposition of some of them traveling through the blood circuit and eventually becoming stranded in the area of dead anaerobic tissue, where they develop into toxin-producing tetanus bacilli.

FAVORITE WOUND TREATMENTS

Applications for Successful Wound Treatment

If a wound is to be stitched, it is washed out with boiled water to which has been added one dram mercuric chlorid and one-half ounce hydrochloric acid to the pint. Then it is stitched and covered with plain sterile gauze, kept moist with five-per-cent solution of carbolic acid in boiled water. The wound is dusted daily with a mixture of boric acid and iodoform. On wounds not closed by sutures I use the following:

Powdered aloes, one ounce; denatured alcohol, four ounces, and linseed oil as much as will suffice to make one pint.

These treatments or applications are made daily. As far as results are concerned, I believe I get primary union as often as any of the general practitioners in the rural districts, and more often than most of them.

In open wounds the aloes-alcohol-and-linseed-oil mixture is a sure winner. I have found poor animals bound with all kinds of mechanical devices (most of them cruel and all of them unnecessary), to keep from gnawing and biting their wounds. I have never seen a wound or sore—surgical, accidental, or constitutional—that the animal would lick, gnaw, or bite after the above dressing had been used twice in twenty-four hours.

P. F. Ash.

Centerville, Iowa.

Nail Pricks

Open the puncture thoroughly to allow good drainage, then cleanse the parts well with a good antiseptic, such as a 1-5000 bichlorid solution, and in severe cases apply the following freely, twice daily:

Iodin cystals 3iv
Sulphuric ether .....ʒviii

Protect the wound from dirt by covering with cotton and a bandage, and as an external protector, a piece of burlap.

I have given this treatment a good trial on cases where pus had burrowed under the sole considerably, and have had the best of results.

Always be sure to give free drainage, and to protect the wound from dirt afterwards. The ether in the above evaporates rapidly when it is applied and leaves an even coating of iodin over the wound, which protects it from infection, thus allowing rapid healing to take place.

I have used this treatment in cases of nail prick where the swelling extended most of the way up the leg, and have seen a rapid subsidence of all swelling after a few applications. W. P. Bossenberger, D.V.M.

Williams, Iowa.

Wound Dressings

When I make an incision, other than for the opening of a sinus or an abscess, I use a dressing of boracic and tannic acids, for two reasons: I want to protect the wound against outside infection and I want the skin and stitches dry so that, barring infection while operating, I shall have healing by first intention. The same applies to accidental wounds that are fresh and can be advantageously stitched.

Where there is pus already in the wound, I use no antiseptics or dressings, except possibly for the first cleansing, or rather washing out, and then my hobby is a light, wine-colored solution of potassium permanganate or a normal salt solution. In this class of wounds, bacterins or nuclein, or both, get me the results, and I let the wounds alone. I simply cleanse around the wound, taking care to keep the discharge from getting in and on the hair as far as possible.

In the case of freshly punctured wounds, if deep, I give antitetanic serum, and, of course, bacterins, but let the wound alone after having secured as good drainage as it is possible to give it.

Occasionally a wound with exuberant granulations needs tannic acid or some styptic even as strong as stibium chlorid to hold it in check.

E. M. Bronson.

Hartford City, Ind.

Things I Have Noticed About Wounds

1. Wire cuts do better in the summer than in winter.
2. I have received very little benefit from the use of bacterins in the treatment of wire cuts.
3. If the periosteum is injured the recovery is greatly retarded.
4. Peroxid of hydrogen does more harm than good.
5. All unnecessary digital manipulation should be avoided.
6. Wounds across the face heal more rapidly than in any other part of the body.
7. Rope burns are harder to heal than wire cuts.
8. The majority of wire cuts come after an electrical storm.

9. Wounds do better with a dry dressing than with liquid applications.

10. Bandages as a rule are a hindrance rather than a help toward rapid recovery.

11. The use of slings is very beneficial in the treatment of open joints of all kinds.

12. Ointments of all kinds are filth gatherers.

13. The common barn sponge has no place in the modern wound treatment.

14. And lastly, the teats in cows are practically the only part of their anatomy that becomes injured from barbed wire, and *beware,* young man, when treating them.

F. H. Burt, M.D.C.

Chenoa, Ill.

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